Some Often Neglected Duties of the Engineer.*

In a recent address before the Institute of Mining Engineers the subject of ethics, as bearing upon engineering practice, was treated with some fullness by the retiring president, Mr. Bayles. It is not my intention to repeat what he has so well said, or to take up the more obvious duties which are so often brought forward in addresses at the commencement season. Such addresses usually treat of those qualities which form the foundation of the character of every really successful engineer, and more especially of the necessity for that absolute honesty of purpose in every relation he holds, whether as designer, as supervisor, or as arbitrator, which alone can lead to the thoroughness of work, and which at once places him on his guard against any dishonest approach, however it may be disguised. Out of this one requirement spring all the *ordinary* duties of the profession; but passing these by we come to ones more recondite, growing out of the relations of the engineer to the profession and to the world of science; and which seem more appropriate for consideration in addressing a society among whose members are men of large professional experience. These latter duties are none the less important, but, in the hurry of active life, they are too often overlooked or but imperfectly performed, and since every dereliction of duty is sure to react to our detriment, it is the part of wisdom to guard watchfully against such in every direction.

Entering, then, upon our subject and proceeding from the lesser to the greater, let us consider first the relations of the chief engineer of an important work to the members of his staff. As a matter of course he expects absolute loyalty on the part of all those under him, and any disloyalty would probably end in the prompt dismissal of the offender. How shall such loyalty be obtained? Shall it be the result of fear, or shall it be bred of mutual regard and confidence? In other words, is the duty *all* on the part of the subordinate, or is there a reciprocal obligation implied on the part of the chief? If the latter question be affirmatively answered, as it must be, let us proceed to state clearly what the obligation is. Here we should remember that the most eminent engineers have all been subordinates, and have had the help of others by which to rise. As an inevitable corollary upon this, it follows that the chief owes it to all in his employ to help them freely in their difficulties, and to be readily approachable. By thus doing he will make them stronger men professionally, and help forward his own success. Our first duty, then, may be defined as that of politeness, affability, and a personal regard for subordinates. Mr. H. H. Richardson, of Boston, the well known architect recently deceased furnished a prominent example of one who nobly fulfilled this duty. In a notice of his life-work the *Sanitary Engineer* writes as follows:

"Nor less delightful than this office in the country was Mr. Richardson's relation to the draughtsmen he employed. Only those who have had the privilege of working under him can have much idea of the generous interest he took in their welfare and artistic progress, encouraging them and advising them in their studies, and ever ready to listen to intelligent suggestions, treating his men as personal friends rather than employés. Often he would invite a number of his older pupils to evening reunions, where he would talk over with them matters relating to their art. His valuable library and collection of photographs was always accessible to his draughtsmen, and he encouraged their constant reference to them. Few men have such power as he had of filling others with his own enthusiasm."

There is a second way in which the chief can help those under him, but to which selfishness often blinds his eyes. It frequently happens in the progress of a work, that the one coming in immediate contact with some of the many problems involved will bring out a solution or work up a design having real merit. The credit for such design does not belong to the chief, and as a matter of simple justice, he should, in making up his reports, give full credit to the designer; yet, in many cases this is not done at all, and the assistant is mentioned in merely general terms and with no reference to his special work. This is not the way to obtain whole-hearted service; a chief engineer can *always* afford to be generous to his helpers. A full acknowledgment of all good work, no matter by whom done, in nowise detracts from his own standing; on the contrary, the world will think the better of him for it. The work is always known afterwards as that of the chief, and if he adds generosity to his other qualities, he will but stand the higher in the estimation of all thinking men. It is said, that one great reason for the popularity of General Grant was his generous treatment of all those under him.

There is yet another duty of the chief, which has much to do with a hearty, loyal helpfulness on the part of subordinates. In the inception and progress of a work, it is he who in a great measure determines the respective salaries to be paid to the other members of his staff. The vicious doctrine that no more will be paid than the market will command, with no regard for the cost of living or for the character of the services rendered, too often prevails, and many men seem to think that if *they* are insured a good salary, it is laudable to cut the salaries of all below them down to the lowest attainable limit. It is only necessary to carry this doctrine to its ultimate conclusion to prove that it is both unjust and unwise. If we want a horse to do his fullest work we do not begin by scanting him in his food, but we give him full provender and the best of care. Are men so different that we can expect them to do their best when they are but half paid for their labors? Is there not sure to be in their minds a rankling sense of injustice? If an assistant so paid be too honest to slight his work, he will still be preoccupied by thoughts of "how to make both ends meet" in his expenses, or how to be able to meet just debts, possibly those incurred in obtaining the education which has fitted him for the very thing he is doing, and as we all know, a preoccupied mind is not fitted for deep or consecutive thought on any subject. The chief should therefore insist at the outset upon full compensation for all services rendered, and should be the first to recognize good and faithful work, by asking for such increase in salary as may be consistent with its value. A man who lets neither time, study, labor, nor expense interfere with his attention to his duties, is certainly worth more than one who works always by the clock (trades unions to the contrary notwithstanding); and a worthy man should not be obliged to ask for that which is rightly his due.

In immediate connection with the subject of organization of a staff arises that of a proper recognition of the relative positions of subordinates; by this is meant the military idea that orders shall be issued and reports received always through those next in rank, and not, as is too often done, with an entire disregard of precedence or system. An engineer has a right to suppose that each one in his place is attending to his duties, and to pass over the one next below him and give an order to a minor, implies a lack of confidence in the first, is likely to cause insubordination in the second, and is sure, eventually, to introduce confusion and ill-feeling in the staff. Having placed a man in position he should be held strictly accountable for all work entrusted to him, and if found unfaithful he should be removed; but to pass him by and ignore him, whether by attempting to do the work personally or by assigning it to others, is an evidence of weakness, and is doing one wrong to mend another.

Such abuse of good management is however, often committed where no *fault* is attributed; in which case it shows a lack of sound ideas as to administrative methods, and is still to be unqualifiedly condemned. Not only does it introduce discord into the service, but in just so far as a man misdirects the labors of those under him and relieves them of their due share of responsibility, does he injure his own efficiency and make his own labors heavier. Here it may not be amiss to quote with proper reservation the advice that has been given engineers to "never do yourself what you can get others to do for you." In a recent obituary notice of a prominent English engineer the following sentence appropriate to the case in point occurs: "The confidence reposed by Mr. Leather in his staff, and the freedom with which its members were thus enabled to grapple with the many sudden emergencies inseparable from sea-works, were also important factors of his success in these undertakings."

It not unfrequently happens that Boards of Direction and other employers show a lack of this confidence in their chief engineer, and are guilty of the gross impropriety of attempting to give personal directions to assistants, or of receiving reports from them.

The practice cannot be too strongly reprehended. It is an axiom in physics that two bodies cannot occupy the same place at the same time, and it is no less true that two *persons* cannot attend to one and the same set of duties at once. Confusion is inevitable. "Dual control" is bound to be a failure whereever undertaken.

The subject of reciprocity of duties between the employer and the employed (or, as a special case, between the engineer and his assistants) is one that is assuming greater prominence now than ever before in the world's history. Men are slowly learning that the rule of selfishness is inevitably and always *misrule*, and that in the complex relationships of our modern civilization, a wrong done to one class is bound in some way to react on all other classes. Heretofore the wealthy and powerful have been the oppressors; but now the laboring man has learned the lesson so well, that he takes delight in entering into a *worse* bondage, in order that by the might of numbers he may inflict loss on those whom he conceives to be his enemies. It is evident that peace and industrial harmony can be again established only on the higher principles of confidence, co-operation, mutual helpfulness, and good-will; in other words, on the golden rule of doing as you would be done by. As has been recently so eloquently said by Bishop Potter: "When capitalists and employers of labor have forever dismissed the fallacy, which may be true enough in the domain of political economy, but is essentially false in the domain of religon, that labor and laborer are alike a commodity, to be bought and sold, employed or dismissed, paid or underpaid as the market shall decree; when the interest of workman and master shall have

*F. Collingwood, M. I. C. E. &c., before the Rensselaer Society of Engineers at Troy, June 15th.

been owned by both as one, and the share of the laboring man shall be something more than a mere wage; when the principle of joint interest in what is produced of all the brains and hands that go to produce it is wisely and generously recognized; when the well-being of our fellow men, their home and food, their pleasures, and their higher moral and spiritual necessities, shall be seen to be matters concerning which we may not dare to say, 'Am I my brothers keeper?' then, but not till then, may we hope those grave social divisions concerning which there need be among us all, as with Israel of old, 'great searchings of heart," But, let us return from this episode.

We have thus far discussed what might be called the *family* relationships of the engineer, and more particularly those duties reaching downward, the duty of each man to lend a helping hand to all below him on a a work; thus insuring the highest efficiency of the staff, and doing incidentally a still better thing, helping all to be stronger and more useful men. There is, however, a larger company of which every engineer forms an integral part and to which he owes certain duties—viz., the profession as a whole; and to this I would next direct your attention.

Here, as in the engineering family, the golden rule should equally guide our actions. Perhaps one of the first ways in which this rule is violated, is in passing judgment upon the works of others, in the way of fault-finding and belittleing them, picking flaws, making small criticisms of design or method, etc.

Does any engineer imagine he raises himself in the opinion of others by so doing, or in any way advances his own prospects of success? It cannot be; the world is, on the whole, fair in his estimate of men; it recognizes and appreciates the generous everywhere, and is just as sure to condemn the opposite. Criticism for the purpose of suggesting improvement is a good thing, but criticism for any other purpose is unworthy a true man. The best of men make mistakes, and are made stronger and better by them, and they suffer quite enough mortification from self-condemnation without the animadversion of men frequently of less calibre or purity of purpose. It has been laid down as a rule that the man who has never made a mistake must have had so limited an experience in work that he is not a safe man to trust.

But the subject of professional honor and generosity leads us to a *second* thought—we are bidden on Divine authority to look upon "the things of others" as well as our own; and this will lead us to hold to a high standard in the matter of engagements.

It is, of course, unprofessional as well as ungentlemanly to do anything to undermine another for the purpose of supplanting him; but I think we may go a step *further*, and say, where a man has been wrongfully discharged because he would not be made a tool of, either in the way of deceiving the public by doctored reports, by winking at dishonesty in whatever form, or for any other disreputable purpose, we may indeed, we *should*, refuse to accept such position, and so uphold our brother in his protest. As a matter of right, also, an offer should not be entertained for the position filled by another, unless his resignation has already been announced. In other words, if the profession is ever to assume its true dignity as a profession, we must never on our part do aught to bring it into discredit, and we should resent the idea that is held by many, that engineers are tools, or a commodity to be bought and sold, and are entitled to no more consideration than a man who is hired by the day.

The matter of engaging engineers has latterly taken a new phase, which puts this mercantile view in a still stronger light. It is nothing less than asking engineers to bid against each other for employment. I think I speak the voice of the Rensselaer Society of Engineers and of the best engineers generally when I say that they will not *knowingly* enter into such competition. A doctor or a lawyer who would condescend to thus act would be justly considered as unworthy of confidence, and why not an engineer, whose position is eminently a confidential one? A large Western city recently sent letters to a number of the most prominent engineers of established reputation, and whose works were known, asking them to send a history of their professional experience and of their qualifications to do a certain work, saying that their names had been mentioned in connection with it as engineer. An alderman, not an engineer, was also sent to visit each man, and report. I happen to know at least *one* veteran engineer who replied, that his work had been before the public for about fifty years, and if *it* did not speak for him, *he* could not speak for himself. Is it too much to say that we owe it not only to ourselves, but to the profession, to make a strong protest against all such indignities? Has it come to this, that a well-earned reputation for honesty, thoroughness of work, and ability as an engineer, shall all pass for nothing, and that a man must furnish his autobiography every time he enters upon a new engagement? Some of the very best men are noted for their modesty, and such a rule once established would result only in advancing those whose chief acquirement is playing a solo on a well-known instrument made usually of brass.

The old times when a man who could measure a ten-acre lot was called an engineer have nearly passed away (we cannot say entirely,) and we now have as engineers a body of trained men, with keen intellects, who have taken pains to fit themselves in the most thorough manner for the conduct of work. The responsibilities they are called upon to assume are *many times* those assumed by any other profession, whether we contemplate them as they affect human life and happiness, or in the financial aspect alone; and shall we allow ourselves to be viewed in the light of mere laborers, and nothing more, on the rule of "so much work, so much pay?" I am sure you will all say no to this—emphatically, no; but we can rise no higher so long as we remain a mere mass of units, with no cohesion, each striving to get ahead of others, with no care for the hindmost. We must cultivate an *esprit de corps* by which we shall come to feel that if one suffers all suffer, by which the world shall know that we do not work merely for hire, and by which we shall make ourselves felt as fully entitled to recognition as professional men, and to be treated accordingly. Nevertheless, it is true that we must live by our profession, and unless we set a proper financial value upon our services, others will not do it for us. It is the duty of every engineer to make his charges to bear a reasonable proportion to the value and importance of the service rendered. That engineers have failed in this regard is evidenced by the fact that almost without exception our best engineers *never* acquire a competence by the legitimate practice of their profession. Like other men, they are sometimes fortunate in an outside speculation, and many abandon the profession and seek for larger returns as contractors; but this does not invalidate the fact that the professional practice of the engineer in this country is *not* remunerative.

That this is not a necessity is shown by the many engineers in foreign lands who become men of wealth and influence. *There*, when a man builds a large and important work, he is knighted and made much of (the latest instance being the knighting of Sir James Brunlees on the recent completion of the tunnel under the Mersey at Liverpool); *here*, he is discharged at perhaps a month's notice, and often before he has had an opportunity of putting on those last finishing touches of which the necessity is not known by his successor, or which are utterly neglected by him. Salaries of $250 per day, and even more for a month continuously, are not uncommon among English engineers, but such fees are unheard of here. American *architects* have gradually come to the agreement to charge five per cent. upon the total cost of a work for plans, specifications; estimates, detail drawings, and such superintendence as is needed to insure a proper rendering of the specifications; but this does not include the payment of a clerk of works, or for extra services in the matter of securing site or anything outside of the work itself, and the charge is greater on small buildings.

In the matter of the Tower Bridge, in London, now under construction, the general design was made by the City Architect, but the engineering features were worked up by an engineer. The total estimated cost, as presented to Parliament, was over $3,000,000, and, after considerable controversy, the sum of $150,000, or 5 per cent. on the estimate, was voted by the Court of Common Council as the rightful payment for the service, to be divided between the architect and engineer as they might agree. This was spoken of as being the "standard commission." Now, while it may not be practicable for us to make this a standard at the present, there is no reason why it may not be a guide where there is no other. Those who have not considered the matter will be startled at the difference between this and the amounts our engineers ordinarily receive. Of course, such a standard cannot be reached in a moment, but it will never be reached if no effort is made. It is not the part of prudence to attempt reforms by violent changes, and I would be far from recommending anything like the unwise methods too often pursued, but we should all set our faces in the right direction.

Let the community learn that the engineer must be an educated man; that to meet the ever-widening calls upon his skill made necessary by the great works of recent times, and the greater ones following on every advance accomplished, he must call to his aid all science, both ancient and modern; that he must know of the labors of others and use them to the best interests of his fellow-men, and that the widest scholarship is now a necessity, and, when this lesson is learned, men will begin to understand that engineering is *indeed* a profession, and worthy of all the emoluments so freely accorded to the other learned professions in the land. It is but just that since from his position as judge and arbiter on the enterprises he helps to develop, he is precluded from investing in them, he should be fully paid for professional services.

In connection with the question of a high standard of professional honor arises a practice (to be deprecated) which is sometimes indulged in, of an engineer acting as adviser and recommending in that capacity an article of which he is the patentee, or in which he is personally interested. An engineer has no right to have any other interest than that of his employer; he degrades the profession and brings discredit upon it whenever he allows himself to be placed in a position where he is actuated by divided motives. He may come forward *avowedly* as the advocate of a special contrivance or method and be entirely blameless, but he may *not* accept service as an engineer and while acting as such so shape re-

ports or designs as to favor his own interests. An anecdote is related of Mr. Alfred W. Craven, when engineer of the Croton Aqueduct, that at one time he had a water meter brought to his notice very favorably and with the request that he take $1,000 of the stock. He said he had no money, but the promoter said that need make no difference, *he* would see to that. As the man left the room, Mr. Craven said: "There is one thing I want to say before you leave, that so long as I am in the department no meter that I am interested in can ever be introduced on the work;" and it never was.

There is another indirect injury done to the profession, which is caused by the rivalry between the large firms connected with the building of bridges and other engineering operations. These furnish information and designs presumably without pay, but really the cost enters into expenses and has to be charged on the cost of the product. There is much to be said on both sides of this question. Uniformity of design certainly tends to cheapen production, but there will also be a tendency to a sameness of thought and to quenching the spirit of investigation and progress. Centralization is the inevitable sequence of the effort to furnish such work at the lowest cost, and the engineers, who are the brains of such establishments, lose their individuality and become but parts of a great machine. It is quite certain that the fairest way of treating the matter would be for a reasonable charge to be always made for designs so furnished.

I come next to a duty which by many seems never to have been even thought of. I refer to the obligation resting upon every man to make known the results of all professional practice, which have novelty or are of value for any other reason. Here the selfish spirit is too apt to rule, with the underlying idea that if technical knowledge be made public others will seize upon it, and by competition interfere with the chances of employment that would otherwise ensue upon exclusive control. It may be questioned whether even upon this low plane of self-interest one's purposes are not best served by publicity. As between a man who has made it evident both practically and by proper publication that he *knows* how to do a certain thing and a man who follows confessedly as a copyist, the first will assuredly be the most likely to be sought out when the same problem is presented a second time. Numerous instances could be pointed out of recent occurrence, but it is not desirable to go further in this direction; we are not concerned at the present with the financial but with the *ethical* question; what is our duty? A digression may here be pardoned for the purpose of pointing out the position which every professional man holds as a unit in the great mass of humanity, as a factor in our modern civilization, and as a debtor to the world of science, literature and art—to do what he can to repay in kind that which he has so bountifully received. He cannot "live to himself alone" even if he would. From the time of his birth he is under the protection of laws which are the outgrowth of centuries of thought and experience, reacted upon, ameliorated, and moulded by the principles of the Christian faith. He is under "tutors and masters" who spend time and labor in correcting his mistakes, showing him the sources of knowledge and leading him by plain paths to the fountain-head. If the labor of others for all the years gone by had not supplied that fountain, in vain would he seek to drink. Generous men everywhere have recorded facts, experiments, theories, experiences, designs, statistics, in order that he "may enter into their labors," and progress from the high vantage-ground thus ready to his hand. In view of all this can any man rightly say that *he* has no duty to perform in return? or that what he discovers is his own, and he will keep it to himself? I verily believe that it is lack of thought which allows the experience gained on so many important works to pass into oblivion and be lost to the world. Lack of time is the usual excuse, but lack of inclination is in many cases the real reason. Whatever it may be, let us see to it that we are not among the delinquents. I would not urge that this be done in a spirit of pride; on the contrary, when a man thinks soundly on such matters and sees how really little of his work is entirely his own, he must ever feel humbled. I would, however, that every one shall feel it to be a sacred duty to record his professional experiences in some proper way, by reports, by papers to societies, or by discussions in technical journals, for the benefit of those who shall follow him. The publishing of full reports might be made more common if we were always faithful in urging the duty upon boards of direction, and such reports are considered by engineers the most satisfactory sources for the latest professional information.

The last duty to which I propose to call your attention is a very practical one, which in several very prominent instances of late has been but imperfectly performed. I refer to the obligation always resting upon an engineer, of making all statements on which proposals are asked in lettings of work, clear and unmistakable. All specifications should be explicit, and state, as nearly as language can, just what the contractor will be called upon to do, and all information attainable as to the nature of the site, difficulties of foundation, etc., should be clearly set forth. In doing this, the engineer should remember that the contractor also has rights which should be fully cared for, and not try to get an undue advantage by any trick of language. One of the cases referred to in which this duty was imperfectly performed was in the specification issued for the Hawkesbury bridge, now under contract to be erected near Sydney, in New South Wales, and which will be the most important structure yet undertaken in the Southern Hemisphere. Here is a bridge which is to cost over one and a half millions of dollars, and of which, in referring to the designs submitted, London *Engineering* says as follows:

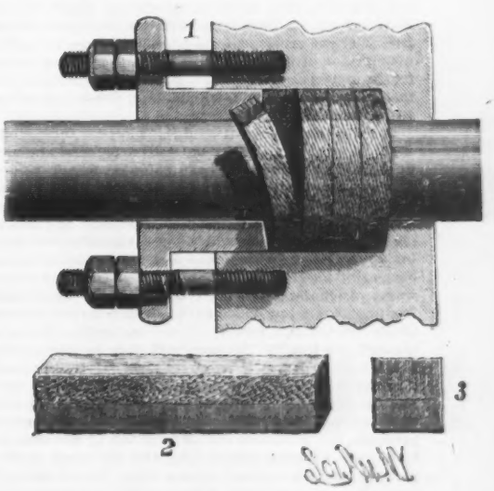
"A bare glance at the designs shows either the piers are unnecessarily massive in some cases, or undoubtedly too slender in others. This great want of uniformity is due, no doubt, to a limiting pressure on the foundations not being specified in the conditions, though minute instructions were given for the superstructure. It seems probable that this lack of information or of conditions regarding the doubtful and most costly portion of the work, may be a reason why so few firms known as bridge builders appear to have availed themselves of the opportunity of tendering, so reducing the competition, to the *disadvantage* of the colony."

In a large work nearer home, a somewhat similar experience has been had, if reports in the papers are to be credited. It seems almost a truism to say an engineer is unfaithful to duty, whenever he allows vagueness to enter in any form into his work, especially in so important a matter as a specification. I know that an engineer is often hurried to bring forth results, and to try sometimes to accomplish impossibilities in the matter of speed; but an energetic protest would in most cases secure the time required; and when it is made perfectly clear that uncertain borings and insufficient examination as to site, indistinctness in requirements or immature plans will be invariably followed by an increase in amount of bids to cover the factor of ignorance, there are few boards which cannot be influenced to a right decision. An engineer is not responsible for additional cost, when too short a time is allowed for proper development of a scheme, or when plans are substantially changed after estimates are made; but he is justly held accountable for wide departures from estimates when time is given for full preparation.

I have thus brought before you some of the ways in which the best of us are at times found wanting. In the rush and turmoil of active practice, and the rapid advances the profession is making in all directions, it behooves us at times to pause and see whither we are drifting, and to adjust our lives anew to the increased responsibilities thrown upon us We are not alone in this regard. Men of all other professions may take some portion of these lessons to heart. As men and citizens, unless we enter fully into the idea and the desire that the world may be in some measure made better and happier from our having lived in it, we have not only much to learn, but we are missing the chiefest end o our existence, We shall reach our most perfect manhood only as we do *all* our work under the fullest appreciation of the meaning contained in that one word—*duty*.

Improved Steam Packing.

The New York Belting and Packing Co., 16 Park Row, has patented an improvement in packing for the pistons, stuffing boxes, etc., of steam engines. The packing of several thicknesses of cotton duck with a lubricating compound was formerly backed with dark rubber, which, when subjected to a high temperature, loses its elasticity and fails to keep the packing steam tight and up to its work. This defect has been eliminated from the new packing by combining with white Para rubber of fine quality, a special lubricant, which will endure a high temperature for a considerable time without deteriorating; this packing being guaranteed to stand a temperature of 300° (F.) for a long time and to stand a heat 50° (F.) higher than the dark rubber, which, in spite of its imperfections, has been a favorite packing with those in charge of steam engines As shown in Fig. 1, the packing is composed of separate rings, but it may also be put on in one continuous coil if desired. Fig. 2 is a side view and Fig. 3 an end view of this packing, which is square in section, and which, from its greater efficiency and durability, will probably be in greater demand than the original style.



The Vyrnwy Embankment.

REPORTS BY MAJOR-GENERAL SIR A. CLARKE AND MR. RUSSEL AITKEN.

From the Liverpool Post, May 28.

In consequence of the statements made by Mr. Hawkesley, the engineer with whom Mr. Deacon, as resident engineer, had charge of the construction of the Vyrnwy embankment, reflecting on the stability of the work, the City Council, in November last, instructed the Water Committee to take the opinion of two eminent engineers as to whether the construction of the embankment across the River Vyrnwy was being carried out in a substantial and workmanlike manner. After some little delay, Major General Sir Andrew Clarke, R. E., Assoc. Inst. C. E., and Mr. Russel Aitken, Mem. Inst. C. E., undertook to inspect the works and report to the committee on the subject. The reports of those two gentlemen were received a short time ago, and having been printed, copies of each have been sent to each member of the Council, for consideration at the monthly meeting on Wednesday next. The following is the text of each report:

Major-General Sir Andrew Clarke's Report.

In continuation of my letter of the 6th January addressed to Mr. Bower, in which I informed him that I had visited the Vyrnwy dam, and that the result of my inspection was sufficient to satisfy me that no apprehension need be entertained as to the character of the work, I now beg to inform you that I have again visited the dam, and to furnish you with a more detailed report on the subject. In discussing this question, it must be borne in mind that masonry dams have hitherto seldom been used in England, where circumstances have generally proved more favorable to the employment of earthern embankments. Hence, possibly the public mind in this country has been ready to entertain feelings of distrust with regard to a structure of more or less known type, especially when designed to uphold a great head of water. But the construction of large masonry dams has been familiar to the French, and subsequently to our own engineers in India, and as the Vyrnwy dam is being constructed under very similar conditions to those which guided the French engineers in the work of the Furens reservoir, and our own General Fife, R. E., in the Karakvasla dam near Poonah, which embanks the great artificial lake which now bears his name, we, fortunately, have trustworthy standards of comparison, both as to design, construction, and workmanship.

The probable causes of failure of masonry dams may be briefly summarized as follows: 1. Geological conditions neglected or unsuspected, such as fissures or faults in the strata, or the intercalation of soft or perishable beds. 2. Resistance wrongly calculated, either from clerical errors, defective assumptions as to the distribution of stress, or insufficient factors of safety for the materials employed. 3. Employment of improper materials, or careless workmanship, due to imperfect supervision.

As to (1), the geological conditions appear to be singularly favorable, and I see no reason to entertain any doubt on this ground. I have satisfied myself as regards (2) that there is in the design an unusually large margin of safety, in whatever way the assumption as to the distribution of stress may be made. As regards (3), I have closely inspected the workmanship and materials, both as now employed and, by means of samples, at various stages since the commencement of the work. Advantage has been taken of the horizontal drainage tunnel provided in the design to sink a trial shaft, measuring 5 feet by 2 feet 6 in., vertically down through the heart of the dam, and thus to expose an actual section, 22 feet in height of masonry, laid during the year 1884. The accompanying tracing shows this section. Samples of concrete, obtained in the course of the excavation of this shaft, have been tested under pressure, the minimum resistance given by any sample being 196.7 tons per square foot, and the mean of fifteen samples 289 tons per square foot. The details of these tests are appended. With a view to ascertain from the only eye witness, whether any, and if so, what changes had been made since the commencement of the work, either in the methods of shaping the stone at the quarry or after leaving the quarry or in the methods of setting the stones and of filling in the concrete between them, I caused a series of questions on these points to be addressed to the resident and assistant engineers, inspectors and gangers, which with their answers, are appended to this report. These answers may be summarized as follows:—At the quarry the bottom beds of the stones are dressed level and free from twist, and from any points which might cause an uneven bearing: at the sides and ends no overhang of more than 12 inches is allowed: the upper faces are dressed with hammer until sharp points are removed. After leaving the quarry, and before being set, some of the stones are reduced in height, and sloping stones are benched to suit adjoining work; any stones found with unduly sharp tops are dressed off to give a foot of bearing on the top surface. In setting the stones a level bed of concrete and macadam, previously prepared, is thoroughly cleaned by washing and brushing; a bed of fine mortar 2½ inches to 3 inches thick is spread over this, and the stone is then bedded level and driven down with mauls. Care is taken that the stone does not touch adjoining ones. The joints are formed with concrete rammed solid with macadam by means of punners and swords. All the witnesses, sixteen in number, are unanimous in saying that no change has taken place since the commencement of the work in the above procedure. From my own inspection, I am satisfied that this is the case, and that the precautions adopted, and the methods used, for ensuring sound good work are now, and have been from the commencement, such as to place beyond any question the solidity and uniformity of the masonry. I have further satisfied myself by actual inspection that the stones are fairly bedded, and rest upon a flat bed of at least 1 inch in thickness of cement mortar, and this, in my judgment, is amply sufficient to ensure that they are in a position to exert their full resistance to crushing. I have caused a great number of plans and sections of the masonry to be made: but, as the bond cannot be accurately represented on paper, I would suggest that a model of some portion of the unfinished work should be made for future reference. At present I can only record my opinion that the precautions taken to ensure a thorough bond, both vertical and horizontal, are amply sufficient and as great as the nature of the cleavage of the stone employed will permit. The manipulation of the cement in the ordinary course of work, and the various processes in mortar and concrete mixing are fully described in Mr. Deacon's report, and I see no reason to suggest any alteration in them. The cement appears to be of the most excellent quality, in fact better them I should have thought it would be practicable to obtain commercially.

To sum up, I am of the opinion that the building of the wall is being well and skilfully carried out, and that the section is so enormously in excess of actual requirements, as evidenced by comparison with other existing masonry dams, that nothing short of an earthquake could possibly disturb it. It would be interesting to ascertain the amount of deflection of the top of the dam, caused by the water pressure when it is filled, and I recommend that accurate measurements for recording this should be taken. The deflection of the Karakvasla dam when incomplete and about 70 feet high, with 50 feet head of water, was ascertained to be ¼-inch in a length of about 500 feet and I should not anticipate even an amount proportionate to this in the present instance. I would add that General Fife accompanied me on my recent visit to the Vyrnwy, as also did Major English, R. E., who has had an extended experience in the construction and demolition of masonry works, and Captain Clarke, R. E., author of "Graphic Statics." AND. CLARKE, 52, Portland-place, 5th May, 1886.

Report by Mr. Russel Aitken.

To the Town-Clerk, Liverpool, 36 Great George street Westminster, April 5, 1886.

SIR:—In your letter to me, dated 21st November last, you informed me that the Water Committee, by the direction of the City Council of Liverpool, desired to have my opinion as to whether the construction of the masonry embankment across the river Vyrnwy "has been carried out in a substantial and workmanlike manner, and so that it will, when completed, answer the purpose for which it was intended." In undertaking an inquiry of this kind, it will be evident to you, that where a work has been going on for some years it is difficult to give so assured an opinion as if I had seen the works in progress from the commencement: and if I had not satisfied myself that every particular herein contained was an accurate description of how the works were carried out from the commencement, I should not now forward this communication to you. In preparing this report I have taken nothing for granted. I have had all the materials of which the dam is composed examined, and some of them analyzed by Mr. Ogston, one of our most trusted practical chemists, a copy of whose report is sent herewith. I have seen the slate of which the dam is principally composed, as well as concrete from the interior of the dam itself, tested for its resistance to crushing. My calculations as to the strength of the dam have been carefully checked. I have visited the works and seen the mode in which the work is put together; and I have taken evidence by examining foremen and workmen who have been employed on the work, some of them from its commencement; and I have done everything in my power to ascertain what the facts of the case actually are.

FOUNDATION.

A masonry dam, such as this, must be founded on rock; and at the site of the Vyrnwy dam the rock, which is clay-slate, has been so denuded by glacier action, and, subsequently, so well protected by the *debris* of the receding glacier that, when uncovered, it was perfectly sound. The dip of the rock, which is at a considerable angle up stream, is the dip most favorable for the retention of the water in the reservoir when the dam is built. The surface of the rock was rather irregular and rugged. Some of the more projecting pieces of rock were blasted off, whilst some of the larger smooth slopes were stepped so as to secure the masonry from slipping. The rock foundation and the manner in which the dam has been founded may be pronounced quite satisfactory.

THE SHAPE OF THE DAM.

The length of the dam and the area of water to be impounded by it do not concern this report. What I have to consider is whether the cross-section of the dam at all points is sufficient to maintain the head of water against it. Whether the area of the water to be sustained by the dam is one acre or ten square miles makes no difference in the weight of water pressing on the dam and tending to overthrow it. My calculations of the strains on the material of a masonry dam, due to pressures caused by the weight of masonry when the reservoir is empty and by the weight of the masonry and the pressure of the water when the reservoir is full, have been made on the lines laid down by me in one of my lectures on "Canals, Reservoir Dams, etc.," delivered at the School of Military Engineering, Chatham, in 1872. I first used these calculations for masonry dams in India in 1868, and they differ from those propounded by the late Professor Rankine in 1871 in this—that my method of calculating these strains requires a somewhat thicker mass of masonry than his does; but, be that as it may, the section of the Vyrnwy dam is more than ample, whether Professor Rankine's or my mode of calculating the strains be adopted. I send herewith a cross-section of the Vyrnwy dam (plan No. 1), in which the strains on the masonry at any points in its height may be measured by scale; and from this it will be seen that the maximum pressure on the masonry, which can be calculated with mathematical precision, is 7.7 tons per square foot when the reservoir is empty, and 8.6 tons when the reservoir is full. This calculation of pressure does not include the effect of the puddle on the inside of the dam and of the filling on the other side which cannot be determined with mathematical accuracy, but it may be assumed that these pressures of 7.7 and 8.6 tons per square foot would practically be slightly exceeded. Such pressures would be perfectly safe if rubble masonry and concrete in good hydraulic lime mortar had been used; but when rich Portland cement mortar has been adopted the cross-section is abundantly strong. The stone (slate) of which the dam is built stands an average pressure of over 800 tons per square foot and the mortar stands, after two years 275 tons per square foot, whilst the concrete, taken out of the bottom of the experimental well-hole in the drainage tunnel sunk into the concrete, made with two to one mortar, stands between 200 and 300 tons per square foot before cracking or showing any signs of failure. The greatest weight per square foot on any part of the masonry is, therefore, only 3 or 4½ per cent. of the actual crushing strain of the cement concrete, and 1 per cent of the crushing strain of the slate of which the dam is actually built. Such large factors of safety are unusual in engineering, and reflect the greatest credit on those who are responsible for the execution of the work and for the selection of the materials used therein. I send herewith (plan No. 2) a cross-section of the Vyrnwy dam, on which I have traced a section of a dam designed by me many years ago for a reservoir in India. The specific gravity of this dam would have been about the same as the Vyrnwy dam. It had an ample margin of safety, and it was so designed that it might have been raised 5 feet higher if required; yet you will see that the mass of this dam is largely exceeded by the dam across the Vyrnwy. The Indian dam was to have been built of rubble masonry with Portland cement mortar or mortar made with lime of Theil.

WORKMANSHIP OF THE MASONRY.

I was furnished with the proportions of the materials used in the dam, which are as follows:—1, large stones in block so large that they require to be handled by the steam cranes, 51.8 per cent.; 2, small stones hand-packed between and over the large blocks, 12.2 per cent.; 3, concrete, including small broken stones rammed into the concrete and beaten down with a rammer, 26.8 per cent.; 4, mortar, 9.2 per cent.—total, 100.0 per cent.

1. *Large Stones in Blocks Handled by Cranes.*—I have purposely not seen your engineer's report, but he has furnished me with the lithographed copies of the sketches of the large stones which accompanied it. These stones constitute over half of the masonry, and the sketches are fair samples of the different varieties of shapes of stones put into the work. A stone eight tons in weight seems a large stone to put into a work along with small stones and concrete; but if we consider the dam as it should be considered—namely, as a mass of masonry, the accompanying cross-section (plan No. 3, Fig. 1) of part of the masonry as actually carried out, shows how small a mass such a stone is in proportion to the whole structure. A glance at this cross-section, which was taken at my request, will

show this more clearly than pages of explanation. It is the nature of the stone in the quarry which always determines the character of the masonry, and with a quarry such as there is at the Vyrnwy Works, I cannot, after a thoughtful consideration of the subject, suggest any improvement in the mode in which the mass of the building should be carried out; except, perhaps, that less cement might safely be used in the upper part of the dam where the pressures are less than four tons per square foot. The error, if any, is now on the safe side. The bed of every large stone is dressed fair and true, and is laid by a steam crane on 1¼ or 2½ inches of cement mortar, into which it is pounded by four or six men with wooden mallets until it is shown to be solidly bedded by the mortar being squeezed out all round the edges of the stone. It is true that when one first sees the masonry of the dam, it appears to be composed of a confused mass of large stones dropped about anyhow; but in reality, after one has seen the work being carried on, it becomes at once apparent that it is very orderly disorder, for from experience the men, after examining the space to be filled and taking a few rough measurements, are able to select large stones well fitted to properly fill the most unpromising-looking corners. I had some plans made of the large stones as actually laid, a copy of which (plan No. 3, Figs. 2 and 3) I send herewith; and it is somewhat curious to observe that, although many of the large stones of one course of masonry, have to some extent been laid without any reference as to how they will bond with the course below or the course to come over it, yet the bond is nearly as good as if all the stones had been selected and set by masons who knew all that was below, and what was coming after. But after all, what is bond when the whole stonework is bound together with cement concrete which will carry a weight of 200 or 250 tons without cracking? It is fair to consider that the tensile breaking strain which such concrete would bear would be more than one-tenth of the compressive crushing strain. We may consider, therefore, that these blocks are held together by a material which will bear a tensile strain of more than twenty or thirty tons per square foot. In France, mortar made with lime of Theil, and with which the Furens and other dams were constructed, is considered to be excellent, but it will only, after a year, stand a tensile strain of seven and one-quarter tons and a crushing strain of thirty-six tons; so that the concrete in the Vyrnwy dam is many times stronger than the mortar used in the reservoir dams in France. This perfectly justifies the reduction in the quantity of cement in the mortar, which was made when the proportion of cement to sand and ground slate was reduced from one to two, to one to two and a half; and, as the pressures diminish in the dam, as the dam rises, a still further reduction in the quantity of cement in the mortar and concrete may safely be made.

2. The small stones, which constitute 12.2 per cent. of the work, are hand-packed between or over parts of the larger stones which may not carry the full dimension of these stones. They are bedded, either in the mortar squeezed out from the beds of the large stones or in mortar and concrete thrown in between them.

3. *Concrete.* Until near the end of 1882 the concrete was in the proportion of one of cement to two of sand and crushed slate, with two of gravel added; now it is composed of one of cement and two and a half of sand and ground slate, and two and a half of gravel. These amounts in cubic yards make about four and a half cubic yards of concrete. The crushed slate is in the proportion of about one in six, and gives plasticity and solidity to the concrete. At the same time my experience is that material, part of which is ground so fine as this is, "kills the cement." That is, as each particle of dust has to be coated with a covering of cement, a larger surface has to be covered with cement than when fine sand is used, the particles of which, although small, are of nearly uniform size. My practical experience convinces me that this is a correct view of the case, although Mr. Ogston's experiments hardly bear me out. At Dover Breakwater, for instance, on which I was employed twenty-three years ago, blocks of one of cement and nine of shingle and clean sand were made, which were so hard that only tools used in working granite could cut them; but if the sand was at all dirty the blocks were not nearly so hard. It is a question, therefore, whether, if you retain the ground slate for the mortar used for bedding the large stones, it would not be better and cheaper to have some clean fine sharp sand mixed with the coarse washed Vyrnwy sand instead of the ground slate. If such a clean sand could be obtained within a reasonable distance, it would effect a considerable saving of cement; and the concrete would be quite as well adapted for its work and as strong as it now is. When the concrete has been thrown in between the large stones set by the steam cranes, broken stone is thrown on it and pounded into it with rammers; this is done in layers, and reduces the amount of cement in the concrete to about one to seven. Now the results of testing the concrete having been so good, it may seem hypercritical of me to say that this is the only part of the manner of building the mass of the structure of the dam I do not quite approve of. It has introduced an uncertain proportion of cement in the material of the concrete, as the men threw on the "blues," as these stones are called, each man according to his own idea; and whereas, when all the stones in the concrete are passed through the mixing machine, each stone gets its own coating of cement, but when the stones are thrust into concrete these stones must obtain their cement by robbing the other stones as well as the sand near them of part of their covering of cement. Of course, when the concrete is so rich in cement as it has hitherto been this mode of working the "blues" into the work may be carried on with impunity; but if less cement be used the work would not be thoroughly solid. Again, in dry weather, although the stones may be watered by hand, yet they are more thoroughly saturated and covered with cement by passing all the materials through the concrete mixing machine than they now are. I have seen good concrete made with one of cement to ten or twelve of sand and gravel when the materials have been clean and free from dirt, and all thoroughly mixed in a good mixing machine.

The mortar used for bedding the large stones, and between all the stones, within 10 feet from the inside face of the dam, is one of cement and two and a half of washed sand and ground slate—formerly it was one to two. The Portland cement, which is used throughout the works, is as good cement as can be got, better, indeed, than I have seen before used in work; and with the exception of one cargo which was rejected for the dam as being too hot, the whole has been made up to or above specification. Formerly, the test section of cement was 1 inch square, moulded with suitable eye-holes for testing. It was kept one day in the air and seven in the water, after which it had to sustain a weight of 4 cwts. for one hour. As this test was always exceeded, the weight was in the last contract raised to 5 cwts., and this is now always exceeded. I examined the testing apparatus, and the whole system of checking the quality of cement. It is a model of exactness, order and method; and a wise discretion has been adopted in not insisting on any fixed weight for cement, for heavy cement is, as often as not, coarsely ground cement, which does not go so far as finely ground cement does in coating the particles of sand and stone, and thus does not make such strong work.

OUTLET SLUICES, ETC., FOR COMPENSATION WATER.

The two outlet pipes, each of which is taken through the dam itself, are not in my opinion the best mode in which the objects aimed at might have been attained. As I say in my lectures before referred to—"by far the best way is to take the outlet pipe through a tunnel in the solid at either side of the dam; by this means all danger is avoided." When the water rises in a reservoir, the stone dam bends slightly, and one object is to get this bending as nearly uniform as possible from each side to the deepest part of the dam where the deflection must be greatest. The disturbance caused by two holes which are practically each 20 feet in diameter, part of which, no doubt, are filled with brickwork, must cause a disturbance in these strains and a consequent variation in the uniform deflection of the dam when the reservoir is filled. I do not anticipate any danger to the dam from this cause, although, I fear, there will be a good deal of leakage along the joints of the brickwork of the arch, for a brick arch set in cement never can be tight, as the cement sets so quickly that the sides of the arch crack, owing to the settlement of the wooden centering on which the arch is built. As a matter of construction, a straight joint right through the dam is bad and should have been avoided. The design of the outlets, although they in no way endanger the work, should be carefully revised, as, hereafter, they may give trouble from leakage, etc.

DRAINAGE CULVERT IN EMBANKMENT AND DRAINS IN MASONRY AT BACK PART OF DAM.

I am of opinion these drains might have been dispensed with. If springs are dangerous anywhere they are dangerous under the front part of the dam; for when the reservoir is full, there is at that point the least weight of masonry to keep them down. I do not anticipate any danger from these strains in the dam; but they practically reduce the thickness of the dam, as a means of retaining the water in the reservoir, and so preventing leakage, to the thickness of masonry between them and the face of the dam next to the water in the reservoir. The inside of the lower part of the dam is lined with good solid puddle up to the present surface of the ground; and it will be well to coat the inside of the dam above the puddle with a layer of cement composition 3 inches thick, consisting of one of cement, one of fine sharp sand, and one-half part of ground slate. This should again be covered with a waterproof coating of paraffine and mineral oil laid on hot. Paraffine practically lasts forever, as frost cannot touch it, and prevents leakage.

The conclusions I have arrived at are:—1st. That the cross-section of the embankment or dam is abundantly strong; and, as far as a most careful inspection of the work can enable me to arrive at a conclusion, the work itself is being carried out exactly as it was from the first, viz.: in a substantial and workmanlike manner, and so that it will, when completed, answer the purpose for which it was intended. 2nd. The quality of work in the Vyrnwy dam is as good as it can be; and the tests show that it, and the material employed, leave nothing to be desired, and that no expense has been spared to attain this object. 3rd. That in the higher portions of the dam, where the pressures are below four tons per square foot, the amount of the cement in the work may, if desired, safely be diminished. 4th. The designs for the outlet works for the compensation water should be carefully reconsidered. 5th. The inside face of the dam should be covered with a composition of a mixture of cement, sand and ground slate.

I am, sir, your obedient servant,

RUSSEL AITKEN.

Report of Mr. A. H. Holmes.

In January last Mr. A. H. Holmes, one of the members of the City Council, submitted to the Water Committee a report of a visit he made to the Vyrnwy works. This report has also been printed and copies sent to the members of the Council. In it Mr. Holmes says he has endeavored to give an unbiased opinion on some of the questions connected with the construction of the masonry dam and other works, and that the people of Liverpool may rest assured that, although they have paid somewhat dearly for it, their work is being done well and substantially. Mr. Holmes then gives his answers to the following questions he put to himself.

1. Has the work been well done? In order to do good work one must have good materials. These have undoubtedly been of the best, and no pains have been spared and no money saved to obtain the very best. The stone is extremely good, though difficult to quarry, and of very irregular shape. The sand, composed principally of ground stone, is of the most excellent quality, and the cement could not be better. The stones are well set, and the irregularity in shape is got over by the way in which the bottom beds are worked to an even surface, and the interstices between them thoroughly and entirely filled up with cement concrete of the best description; in fact, it is useless to prolong this portion of my report, for there is no doubt about it that the masonry in the dam at the Vyrnwy water-works is of the very best description, and this must be clear to every one. I assert, without hesitation, that the people of Liverpool may rely upon this, that they have in this dam a piece of masonry that cannot be surpassed for solidity by any masonry in the world. If thousands had been further spent in squaring all the stones and making the whole dam a piece of *ashlar* masonry, I do not believe they would have had a stronger or more durable wall.

2. Has the work been done economically? I think there can be no two opinions that the work could have been done more economically had it been let to some contractor, who would have been bound to do certain things for a certain sum of money, and who would have been superintended by the engineer, whose work it is to design and overlook, but not to construct. For reasons that I need not enter on, it was considered that it would be better that the work should be done by the Corporation themselves, or perhaps I should say by the Water Committee and their officials. They did the most sensible thing they could have done, and engaged Mr. Martin, a gentleman of great experience in contracting, to take charge of the work. They also established a very elaborate system of book-keeping, by which the cost of everything could be readily ascertained. They also obtained plant of the very best description, and yet the original estimate must be largely exceeded.

This increase in cost has been caused in two ways:—(1) By alteration in the works. (2) By an extravagant mode of procedure in carrying them out. First I will deal with the alteration in the works. These are principally the substitution of a stone dam for the earthwork one originally intended and the building of long brick culverts in connection with the sluices on the pipe line. The sum down for the embankment in the original estimate appears to have been, with bywashes, etc., something like £120,000. The cost of the masonry dam will be something like (approximately) £550,000. Who is answerable for the alteration it appears difficult to discover. Mr. Deacon appears to have mentioned to the chairman of the Water Committee that he would very much like to substitute masonry for the earthwork and puddle. Strange to say, the chief engineer had mentioned the same thing a few days before, and some one else had said that some one remembered having heard that a waterspout had once been seen deluging some places some miles away, and so the thing was done, and the committee had pledged themselves to an increased expenditure of one-third the amount set down for the construction of the whole water-works. Mr. Hawksley has designed many reser-

voirs in this country, some no doubt where as great a height of water has to be impound'ed as in this case. The corporation of Liverpool have themselves constructed reservoirs, if not of the same extent, of equal or greater height of embankment, and all of them of earthwork. Then why this sudden change and this frightful increase of expenditure? That Mr. Hawksley did not determine on the earthwork bank without due consideration is shown by his putting it in his Parliamentary estimate, and yet he and the committee abandon it on hearing some story of a waterspout, and at an enormous cost put in its place what I believe is the only masonry dam of any size in the United Kingdom. In this way we account for an excess of expenditure of £430,000. The work has no doubt been carried on extravagantly. I had heard a good deal about a large staff of assistants, etc., and horses, carriages, and luxurious offices, but I do not think there is much need of complaint in these matters. There are certainly more book-keepers, checkers, foremen and managers than would have been employed by an ordinary contractor; but with the system of doing the work under the management of the Corp ration's own servants no doubt they are necessary. As regards horses and carriages, no more are kept than are required to convey the numerous engineers, assistants and others from the stations and about the works. The offices are such as would have been erected by any contractor.

Where money has been recklessly spent has been in the great wall, and this wall must have cost from commencement until now something like 32s per cubic yard, that is, with all charges for plant and supervision. At present, the system having been somewhat improved, it is costing 28s per cubic yard. Now, when we consider that masonry in bridges and retaining walls is commonly done (set in lime mortar) for about 14s per cubic yard, and 19s per cubic yard in cement mortar, this 28s does seems a very extravagant price. I may be wrong, but I do not hesitate to say that a contractor would have done this work at a very little over 20s a yard. There is great waste in the quarry. For every block of stone that is quarried and brought to the wall there is at least as much stone thrown away —pieces that are considered too small or too irregular to be used in the work. It must be admitted that the quarry is not a very good one, still I cannot but think that the engineer has been too particular as to the proportion of large stones in the masonry, and that he might, considering the splendid character of his mortar, have used a larger quantity of the rubble stone now tipped to waste. I certainly think that in this respect a saving of 2s or 3s a cubic yard could easily have been effected without detriment to the work.

There has been used in the construction of this wall cement mortar of the most excellent description. I think a very great saving might have been effected. 1st, If cement mortar had only been partially used, or if hydraulic lime had been used instead of cement; and, 2nd, if the cement mortar had been mixed in the proportion of three of cement to one of sand, instead of two of cement to one of sand; and 3rd, if the cement had been bought more cheaply. (1) I believe large masonry dams have been constructed abroad entirely of hydraulic lime mortar, and have been very successful. Why, then, should not this dam have been dealt with in the same way? I have no doubt had this been done it would have resulted in a saving of 5s per cubic yard. (2) The proportion of two of sand to one of cement makes a very strong mortar. Most engineers think that a composition of three or four to one is sufficiently strong for cement mortar in work of this sort. In this way 1s per cubic yard might have been also saved. (3) The cement that has been used is, no doubt, of very excellent quality. It has cost, I suppose, on the average about £3 5s a ton on the works. I cannot but think that cement capable of producing mortar of nearly equal quality might have been obtained at £2 5s per ton. In this way perhaps 1s per cubic yard might have been saved.

There is at this moment a most expensive piece of work being constructed where an economy might at once be practised. The backing to one of the two arches that go through the dam is being built in blue bricks, that cost 90s per thousand on the works. This means that the brickwork, with the cement and labor (getting the bricks into the place, etc.,) costs about 45s per cubic yard. There is no reason at all why the brickwork should not be superseded by the ordinary masonry of the dam that cost from 27s to 32s per cubic yard. I cannot at present recollect any other means by which a saving could be effected; the cost of supervision is very great, and bears a heavy proportion to the actual work. I think this charge should be reduced, but without going more into detail I cannot suggest in what direction.

III.—The question then arises, What is best to be done under the circumstances? Mr. Hawksley has resigned; are we to employ another engineer in his place? Can we rely that the work will be carried out with safety and economy by our present staff? Would it be expedient, even at this late hour, to ask a few well-known contractors to give an estimate for finishing the work? To these I must reply that I think the great engineering questions are settled, and it would be a needless expense to invite any other engineer to take up the reins laid down by Mr. Hawksley. Mr. Deacon (whatever he may have been years ago) is now, undoubtedly, a most able engineer; he is thoroughly conversant with every detail of the work that has been done, and the work that has still to be done. I think no one can take up his report and read it through without being convinced of this, and without being assured that his theoretical labors have been crowned with practical success. At this time, when less than one-third of the dam has to be done, it would be unwise to make a great change in the mode of c nstruction, or to employ a contractor and his staff in place of those who have carried out the work up to the present. Still I should advise that certain economies should be practised. The staff should gradually be reduced; this could easily be done now that the work is drawing to a close. Masonry should be substituted for the blue brick work still to be done over the arches. The viaduct that is to carry the new road over the dam should be built in lime mortar instead of in cement. The stone *debris* from the quarries should be used for pitching the banks of the lake, and this work should be let to a few gangs of trustworthy men (this item of pitching I do not notice mentioned in the quantities, but it will have to be done.) The large reservoir near Oswestry (which is one made to hold ten times the quantity of water intended in the original estimate, should be let to some well-known contractors, together with any viaducts, bridges, valve-houses, and other works not in the neighborhood of the Vyrnwy valley. By these means I think we should be able to obtain a correct estimate in a few months of the sum of money it will take to complete the works, and so put an end to the doubts that are entertained on this subject.

I have then come to the following conclusions:—1. That the work has been well done. 2. That, though it has not been economically done, the increased cost is principally due to alterations of design, and not altogether to extravagant working. 3. It is best to pursue the course at present adopted with the dam and the works at Vyrnwy, but to endeavor to let as much of the work not yet commenced as can be done conveniently.

Municipal Engineering; Paper No. 2.*

PROVIDENCE, RHODE ISLAND.

(*Continued from Page* 380).

As usual in old cities the streets of Providence were not laid out with any system, but have apparently grown without a general plan.

Even now the city authorities exercise no control over the location of streets in any large tract of land which some individual owner is putting upon the market for building purposes. The owner divides the land according to his individual idea of greatest personal profit, and later, the city accepts the streets as they lie, if it thinks such action is advisable.

The lack of a general fixed plan properly providing for future extensions has occasioned many very expensive changes in the location and width of streets. Under existing regulations the city will gratuitously mark upon the ground the lines and grades of streets for parties designing to build; provided, that it is requested to do so by the individual.

A comprehensive co-ordinate or triangular survey of the city has been commenced, and a system of sectional maps started on this plan, using earlier surveys in part and connecting these by new work. The general plan of these surveys, with scale and size of maps and degree of accuracy required, may be outlined as follows:

Notes from old plans known to be reasonably accurate are combined with new work to form large traverses, the various stations of which are located by co-ordinates relating to the true meridian and a line crossing the same at right angles at the station on Fort Independence (so called) established by the United States Civil Service. The scale is 1-500 which allows the use of metric scales if the same should come into use.

Maps are about 32 inches square corresponding with distances of 1,312.35 feet or 400 meters. There is also an external margin of an inch. No arbitrary standard of accuracy has been fixed; results vary which may be partially due to slightly differing standards of measurements used in the various surveys. The larger traverses close very accurately but trouble is sometimes experienced with subdivisions and tie-lines.

The present or anticipated uses of such a survey are greater accuracy in maps of the city and parts of the same made for topographical and other purposes, convenient location of the true meridian in all parts of the city, and in the future, in connection with a careful triangular survey, such maps may be made a means of the accurate location and record of property lines.

About 1854 maps were made, for the use of the assessors of taxes, of the city as then bounded. Maps of the Ninth Ward, (annexed in 1868) and of the Tenth Ward (annexed in 1874) were made shortly after they were taken into the city. It is very uncertain whether the earlier maps were made from actual survey, or by compilations from records and private maps. The later maps were compiled as far as convenient and some were made from actual survey with "transit and a tape-line."

The earlier assessors' maps show buildings and other improvements; but the later ones do not and the old ones are not revised to correspond with the many changes.

Standards of Measurements, etc.—The United States standard of measurements is used in testing tape-lines, chains, etc., but with some doubt as to its absolute accuracy owing to difficulties in making comparisons. Steel or brass tapes are used for all accurate measurements, and these are tested on three copper bolts placed at intervals of about 50 feet in the granite steps of the Union Passenger Depot near the City Hall; corrections are made by a known amount for temperature, etc.

Grades of Streets.—The grade of a street is established or defined by the Board of Aldermen; provided, that the street has been accepted by the city as a public highway. If the streets are platted by private parties for the sale of house lots and the plat is recorded in the Recorders' office, the grade may be defined by the Board of Aldermen upon request of the city council; and the grade so defined becomes the established grade when the street is later accepted by the city.

For purposes of record a plan and profile of the street is usually made. The plan shows the division of estates, ownership and houses; and the profile gives the contour of the center of the street at 50 feet stations, and also the levels of the sills and ground lines of houses adjoining the street. The grade is shown by elevations above a fixed base (being high-water mark as adopted by the City Engineer's office in 1867) given on each curb-line at each change of grade and at street intersections. Distances are given between each elevation with the rate per 100 feet. The building act requires the City Engineer to mark the grade upon the ground, when it is properly established, for all parties making application to build.

Breaking Streets for Sewer, Water, etc.—The breaking or opening of streets is governed by city ordinances as follows:—

SECT. 14. Whenever the convenience of any person or persons or corporation requires the taking up of any pavement, or the digging of any trench, or hole in any of the streets or highways, such person or persons, or corporation shall first pay to the city treasurer to and for the use of the city, the sum of $2, and shall also give notice thereof in writing to the highway commissioners, who shall examine such street or highway before the same shall be broken up, and if any person or persons or corporation shall, for six hours of day-

*Copyrighted by ENGINEERING NEWS PUBLISHING Co., 1886.

light after the completion of the work for which such opening was made, omit to fill up or repair such highway to the satisfaction of the highway commissioners, said commissioners shall fill up or repair the same in a proper manner, and deliver to the city treasurer a statement of the cost, with reasonable charges for superintendence of the same, and the city treasurer shall cause the amount to be collected of the person or corporation causing such street or highway to be opened. And whenever any excavation is made or any obstruction exists in any street or highway, the person or corporation having charge of such excavation, or causing such obstruction, shall cause signs to be placed across such street or highway, on each side of such excavation or obstruction, with the words "No passing through" painted thereon in dark letters, not less than 2½ inches in length, upon a dark ground, and whenever any trench or hole must of necessity remain after dark, the person making any such trench or hole, or employing any one so to do, shall cause a sufficient light to be kept placed over or near the same from sunset to sunrise, so as to give notice to all persons passing in or through such street or highway.

Before making any extended improvements in streets such as building or rebuilding, or paving, it is customary to notify the gas company that they may lay or relay their pipe. The paving, sewer and water departments are all under one head or superintendent, so that the work is done properly and in conjunction if need be.

(TO BE CONTINUED.)

Agudio's System of Cable Roads.

Agudio proposed his system of cable roads in 1863, and constructed a trial-section along the line from Turin to Genoa. The principal purpose of Agudio's invention was to apply it to the crossing of the Alps, thus avoiding long tunnels. The main feature of this system is an endless wire rope moving rapidly along a single track railroad, and moving a locomotor by the aid of pulleys—by which the speed is decreased—and by artificial friction (either by a halser or a rack-rail or a center-rail, as used in Fell's system.)

Recently a railroad has been built by Agudio; it runs from Turin to the Superga. It was opened in May, 1884, at the time of the Italian National Exhibition. This road starts from a steam street railroad, about one hour from Turin, and ascends the top of the Superga, where the sepulchral chapel of the royal family of Italy stands. The view of the Alps from this point is perhaps the finest in existence, and the number of visitors is very large. The total length of the cable road is 1.94 miles; its sharpest curve is 5° 45′, and the maximum grade 20 per cent. The earthwork and the structures are of little importance; two small tunnels are traversed by the line.

The general arrangement of this line is shown in Figs. 1 and 2. The engine-house, at the lower end of the road, contains two large steam engines, each of 250 horse power; 4 Cornish boilers are used. A repair-shop adjoins the engine-house. The engines make fifty-five revolutions per minute and move the driving pulley (*A*, Fig. 1) which is 13 1 feet in diameter. The three other pulleys *B*, *C* and *D* have the same diameter. *C* sits on a sliding frame provided with a counter-weight to neutralize the stretching of the cable. The cable takes three turns around the pulleys *A*

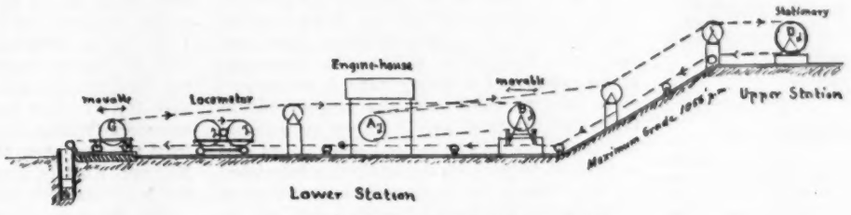


Fig. 1. General Arrangement of the rail-road.

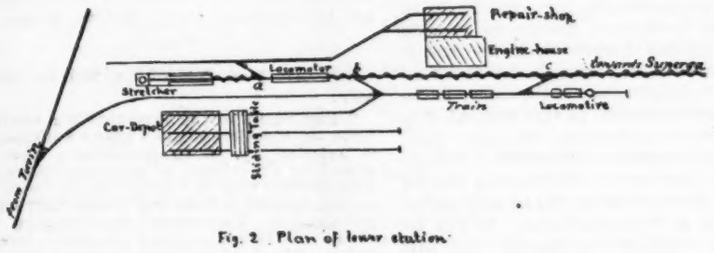


Fig. 2. Plan of lower station.

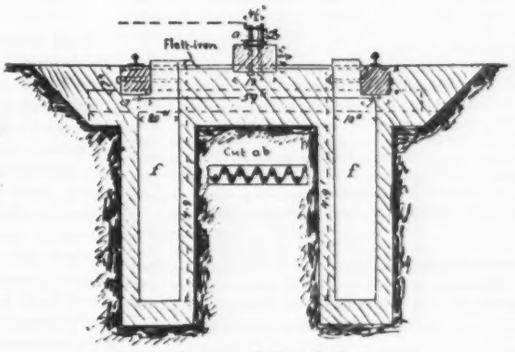


Fig. 3. Section of Roadbed.

The Superga Cable Railroad.

and *B*. The lower part of the cable runs on low pulleys, of 1.15 feet diameter; there are 274 pulleys of this kind on this road. The upper part of the cable is supported on straight lines by 52 brick piers, carrying vertical pulleys of 3.28 feet diameter; fifteen pulleys are used in curves; they are set inclined and have a diameter of 7.55 feet to 8.20 feet. The total length of the endless rope is 4.04 miles; one running foot weighs one pound; its diameter is 0.88 inch; it is made of 6 strands, each having eight steel-wires. The velocity of the rope varies from 39 to 43 feet per second. All the driving and guide pulleys are situated on one side of the track.

The locomotor runs 6.5 feet to 10 feet per second, being from four to five times slower than the rope. This is the reason, that the size of the rope needed is only one quarter or one half as large as if it were directly applied to the cars. The locomotor is capable—at that velocity—of moving thirty-six tons, including its own weight, up the mountain; it is attached to the lower end of the train. The propulsion is done by means of a gear-wheel and a rack-rail. Fig. 3 shows the arrangements of the superstructure; the width of the track is 4.89 feet from center to center of rails. The posts *f f*, securing the track against longitudinal movements, are set under each alternate transverse flat iron bar; the latter are put in at different distances according to the grade, in an average at every 3 feet. When the train goes down, the cable remains at rest; it revolves around the pulleys of the locomotor. Powerful brakes are used to reduce the speed. At first wooden brake-blocks were used, but they made such an obnoxious smoke, that they were replaced by cast-iron shoes.

The communication between the locomotor and the engine house during the trip is done by telegraph. A wire runs alongside the track; by touching the same with a wire from the locomotor signals can be given. The train can be stopped independently from the engine-house, by throwing out a coupling of the locomotor. The same has two independent extra brakes, besides the usual ones.

The cars of the steam street railroad are pushed by the street locomotive and by hand over a series of switches from the street railroad track in front of the locomotor; the passengers do not leave their car (Fig. 2). This arrangement requires that the rack rail must be lowered when the train has passed the switch. This switch arrangement has not been very successful.

R. Goering. Centralblatt der Bauverwaltung May 30 1885.

A Year on the Brooklyn Bridge.

At the annual meeting of the Trustees of the New York and Brooklyn Bridge on the 12th, James Howell was unanimously re-elected President and J. Adriance Bush Vice-President. Said Mr Howell, in accepting the position, "I have endeavored to make the bridge a success. I believe that very soon the receipts will amount to $3,000 a day. The average receipts for May, 1885, were exceeded by those of May, 1886, by $490 per day. To accomplish the result I have alluded to we shall require to expend about $150,000. We have got to build a new engine house, the New York extension will cost about $25,000, the extension of the platforms and stairways will cost, between 10,000 and $15,000, the extension on the Brooklyn side will cost about $25,000. After that there will be nothing more required for the bridge for three or four years."

The annual report of the treasurer showed that the gross receipts from traffic in the year ending May $30,1886, were $680,466.87, of which $18,777.37 came from the promenade, $60, 728. 45 from the carriageways, and $600.951.05 from the railroad. The receipts for 1883, the first year of the bridge's existence, were $402,938 and for 1884, 265,344. 46. The number of passengers using the promenade and railroad during the year was 25,082,587, the promenade being patronized by 93,239,337; the railroad by 1,843,250. The cost of maintenance of the bridge during the year amounted to $550,601. 43; $100,000 was paid to the city of Brooklyn on Aug. 13, and $80,000 on Dec. 21; $50,000 was paid to the city of New York on Aug. 13, and $40,000 on Dec. 21. The total disbursements during the year were $820,601 42. On June 1 the cash on hand amounted to $92,584.33.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

VOL. XV. Saturday, June 19, 1886.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.

D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

TERMS OF SUBSCRIPTION,

TO U. S. AND CANADA.

One Year	$5.00
Six Months	2.50
Three Months	1.50
Single Copies	12 cts.

OTHER COUNTRIES.

Add Postage 3 cents for each number.

TABLE OF CONTENTS.

	PAGE
Some Often Neglected Duties of the Engineer	385
Improved Steam Packing (*Illustrated*)	387
The Vyrnwy Embankment	388
Municipal Engineering	390
Agudio's System of Cable Roads (*Illustrated*)	391
A year on the Brooklyn Bridge	390
Editorial Notes	392
Topography *vs.* Geology	393
Where Money can be Made	393
Preparatory School Education	393
Tunnel Ventilation	394
Personal	394
David Van Nostrand	395
American Society of Civil Engineers	395
Correspondence	395
River and Harbor Improvements	397
Shreveport Water-Works, and Sewerage Specifications	398
Water	399
News of the Week	399
Trade Notes	400
Market Report	400

WE called attention in our last issue to the fact that the technical and engineering journals of this country had been almost without exception silent as to Mr. Dorsey's interesting and valuable paper comparing English and American railroads, saving, that aside from the readers of the ENGINEERING NEWS few know of its conclusions unless they were members of the American Society of Civil Engineers or saw *Engineering*.

That paper for June 4th, has a very full report of the discussion on the paper, pointing out with emphasis the fact that during the last thirty years the economy and efficiency of transportation on the roads of the United Kingdom has remained about stationery, while on our roads the freight train load has increased 159 per cent., and the average cost of moving one ton or one passenger a mile has decreased 51 per cent.

The American correspondent of *Engineering* concludes his report: "It appears while the English railways have practically remained stationery in thirty years, the American railways have, by improvement and economy, reduced their expenses more than half, and in some instances to two-thirds. It is hoped that some of your English managers may be found who will either explain or controvert these figures; as it now stands it would seem as if the great claims of Englishmen about their railways were either based on assertions or on false figures." "The great regret of the Society of Civil Engineers has been and is still that no Englishman seems to have the nerve or the backing to lift Mr. Dorsey's gauntlet which he has boldly flung down."

It is to be hoped that this very fair challenge will bring a reply, not that it is desirable to have a contention over the question, but as England is still the chief servant of the world any amelioration of her abnormally high freight rates will be of great advantage to the countries trading with her, and as competition between her roads, in the American sense of that term, seems impossible, we can only look to see those rates reduced through disseminating knowledge of sounder and more economical principles of railroad management, and that can best be accomplished by a thorough discussion of the whole question by the intelligent and courteous gentlemen whose training and experience gives them so much interest in the conclusion that would be reached if this course were adopted. But as from the well known promptness of that paper's American correspondent, the article must have been in the office of *Engineering* about three weeks without any flaws in either the data or the reasoning deduced therefrom presenting itself to the talent at the comamnd of our intelligent contemporary, it seems possible that we shall lack the mutual advantages that would so surely follow an international discussion of the data bearing on this important subject, so industriously tabulated by Mr. Dorsey, and the conclusions that seem irresistible if the facts presented can not be impeached.

THE city of Shreveport, containing about 12,000 inhabitants, and being the second city in the State of Louisiana, desires to provide itself with a system of water-works and sewerage, and hence invites proposals for the construction and maintenance of the same. These are advertised elsewhere in this journal this week, and the specifications are also published for the benefit of contractors. A map, showing the scheme of distribution, can be seen at this office, or can be had by addressing Mayor Currie at Shreveport, La. It will be seen that a contractor is wanted who will build the necessary works at his own expense, and on the terms of payment offered by the city. The city itself has no authority to issue bonds; but there is every reason to believe that the citizens are anxious for a better sanitary condition of affairs, and will be ready to make very favorable terms with the contractor who shows the ability and intention to give them a good water and sewerage system.

We call attention to the sewerage part of the ordinance. A "tub" system is now in use in Shreveport; it costs fully $20,000 to maintain, and on account of its very offensive nature it is desired by the citizens to abolish it, and as the City Council has extraordinary powers granted them for enforcing proper sanitary measures, it can compel at least 3,000 extra water taps to add to the other use of water. It is very reasonably supposed that there will be a universal adoption of water closets as soon as the sewer connections can be made. The sewers thus become a large source of revenue, and the authorities estimate that full $15,000 per annum can be realized from them.

IN our issue of April 24th we called attention to the obstructive and narrow-minded comments of the press of this city on the annual River and Harbor bill, and their effectiveness in preventing such appropriations for the harbor of New York as its commerce fairly demands.

Senator Miller of this state, in an interview with one of the *Tribune's* reporters, adopts our views, saying, of the proposal to deepen the channel at Sandy Hook.

The tendency of the New York press is to criticise and growl about the appropriations in the River and Harbor bill, but the River and Harbor bill will be passed whether ew York sanctions its appropriations or not Our folks do not seem to understand that the member of Congress who is seeking an appropriation of $10,000, $15,000 or $20,000 for some harbor in his bailiwick feels that his appropriation is of just as much importance to his district as the proposed appropriation at Sandy Hook is to the city of New York. He is elected to represent his district. He holds that it is his business to get this appropriation for his district. When we say that we are against any appropriations for his little harbor he very naturally says he is against any appropriation for our big harbor. Facts must be looked upon just as they exist. New York can get this appropriation of a million dollars to start the Sandy Hook improvement, which will require $5,000,000 or $6,000,000 all told in four or five years, or she can let it alone and go on fighting the River and Harbor bill, which will be passed whether she fights it or not.

The Senator might have said that the appropriation of $10,000 or $20,000 for the smaller harbor is of nearly as much importance to New York as to the locality at which the money is spent, for as of old, all roads led to Rome so at present all economies of production or transportation increase the demand for the products that are distributed through this city, and how much greater our internal commerce is than our foreign, may be inferred from the fact that the tonnage through the Kill von Kull is greater than that through the Narrows both coastwise and foreign.

The Senator objects to a proposal which has been made to put the improvement under the charge of a commission, in which objection he will have the hearty support of all who have watched our commission on the New Croton Aqueduct and on the Harlem Bridge.

THE Liverpool *Post* of May 28th say editorially:

"The report of the investigating engineers upon the stability of the Vyrnwy embankment is satisfactory. Both gentlemen have had abundant experience of masonry dams, and both declare that the great wall is more than strong enough to bear any strain that can be put upon it. They assert that nothing short of an earthquake could possibly break it down. The workmanship is declared to be thoroughly good. A tunnel has been bored into the structure, and a considerable section of the int rior masonry thus laid bare. The engineers are quite satisfied with what they saw, and the public will be glad to think that Mr. Hawksley's fears were unfounded. One of the reports published elsewhere criticizes the design while praising the execution. The writer gives technical reasons for considering that the escape sluices might be improved, and he is dubious as to the utility of the novel system of drainage tubes built into the masonry. He does not think, however, that these defects, if defects they are, in any way endanger the stability of the dam. It is only fair to Mr. Deacon and the Water Committee to say that they have won their case. In view of the statements which had been made public, it was very necessary that a searching inquiry should be made. That inquiry has shown that no further fear need be felt, and now let us hope that the reservoir will be completed with all possible speed, and that something will be done to check that very lavish expenditure of public money of which Mr. Holmes writes in such forcible terms."

WE publish in full this week the report on the Vyrnwy dam, above referred to, as any information relating to large masonry dams is now of very great interest to the profession and to many others in this country, and in this city particularly. The Quaker Bridge Dam of the new Croton Aqueduct is to be the largest masonry dam ever planned, and engineers, commissioners and contractors (to say nothing of the wiseacres of the Union League Club of this city) are interested in the literature of this now not very familiar subject. We have no doubt they will find in the report here given much valuable information, and we hope, on the return of the absent editor of this journal, to be able to give the results of personal observations of the great Liverpool dam.

Topography versus Geology.

Topography is that branch of civil engineering which has for its object the determination of all the natural and artificial features of a country, and the construction of accurate maps of the same. The basis of topographical surveying is mathematics, pure and applied; for all the methods used for locating points depend upon geometrical principles, and all the field observations are but practical applications of these principles. The training of a topographer, whether it be in triangulation, in levelling, in stadia work, or in map construction, is essentially mathematical, accuracy being the first consideration and rapidity the second.

Geology is that science which has for its object the study of rocks, minerals, and fossils, and the investigation of their origin and modes of occurrence. To discover these facts geologists often lay down, by means of colors, on a map, the distribution of the surface rocks. The map used for this purpose should be the best one obtainable, and preferably, a map showing the topography. It is thus seen that the topographical maps of a country are useful for the purposes of the geologist, as well as for the studies of the civil engineer in planning systems of water supply or laying out the best lines for roads.

During the past four or five years the United States Geological Bureau, under the directorship of Major J. W. Powell, has taken the position that the construction of topographical maps is one of its necessary and legal functions, and accordingly has begun in several parts of the country the execution of detailed topography. For this purpose it is doing the astronomical work of determining latitude, longitude and azimuth, the geodetic work of triangulations for locating stations, as well as all the mathematical work incident to field surveying and the construction of maps. It is because we believe this procedure improper, if not illegal, and that topography done by geologists will not in general be sufficiently accurate for the use of civil engineers, that we call attention to the subject.

The report of the joint congressional commission on the organization of the government surveys, published a month or two ago, contains a mass of testimony, which will not only be very useful to Congress, but to the country at large. The lengthy and detailed testimony of Major Powell has a particular value, for although his special studies have been in the line of ethnology, he has long been identified with the survey of the territories, and his arguments for the execution of topography by geologists are the strongest which we have seen presented. The testimony of Professor Hilgard and other experts from the Coast and Geodetic Survey is also very valuable, for the work of this office in topography has long been known as of the most thorough character, but we must express our surprise that they assumed merely the defensive under the attacks of Major Powell, and did not urge the point that precise topography should be done by mathematicians and not by geologists.

Director Powell tells us that the cost of topography as done by his bureau will be from $1.50 per square mile on the prairies and plains to $5 per square mile in the eastern portion of the United States, and that this will cover the astronomical work, the triangulation, levelling work, topographic work and all other elements of cost except the engraving and printing of the maps. This estimate will be a great surprise to civil engineers, who have executed topography for the location of railroads or for the planning of water supply. Topography at $5 per square mile may be of some value to a geologist, but not to the civil engineer. The small sum of $5 will enable a party to hastily sketch the contours and natural features in a square mile of area, but how it can be done with any degree of instrumental precision is difficult to understand. We have been accustomed to consider that $15 or $20 per square mile would produce a topographic map of a fair degree of accuracy, and we know of no work done for a much less sum which would deserve to be called topography proper. A reconnaissance may be made for the sum of $1 or $2 per square mile which is a fair reconnaissance but nothing more. Topography based on a triangulation of satisfactory precision cannot be done for $5 per square mile, for the triangulation itself will cost nearly that sum.

It is no economy to rush hastily over a country making sketches and estimates, and publishing the results in the form of maps. Such work is misleading and in a few years will justly be regarded as a reconnaissance only which forms but a basis for the true topography. For example, take the western surveys of King, Wheeler and others, concerning which Major Powell in 1878 testified that, although called scientific, they were practically "in the air," because the fundamental conditions of accuracy had been neglected. Such work in a new, undeveloped country has a value, but, we say, let it be called by its right name and not be sent forth as a precise topographical survey. Particularly is this true for the eastern coast of the United States, where the only proper economy is to spend a sufficient sum to produce a proper topographical map, instead of publishing the results of a reconnaissance at $5 per square mile, which in a few years must be resurveyed and republished.

In the re-organization of the government scientific bureaus we should be glad to see one department, the coast and geodetic survey for instance, charged with all the work of map making, the astronomy, the geodetic triangulations, the hypsometry, the topography, the hydrography and the parcelling of the public lands. All of this is work requiring special training of a mathematical and civil engineering kind, and should not be entrusted to geologists whose training has been of a different character, and whose achievements in map making during the past fifteen years have been open to much criticism. Let the geological bureau confine itself to rocks, ores and fossils; let it even continue to publish works on zoology, ethnology and linguistics; but let it not be entrusted with the work of topography which from its nature and from the necessity of securing precision, requires the mathematical training of the surveyor and civil engineer to successfully execute.

Where Money can be Made.

Of thriving Canadian towns, Smith's Falls, (most unromantically named) situated twenty-eight miles from the St. Lawrence river, on the Canadian Pacific railway, is one of the most promising for parties wishing to invest in land that is sure to appreciate in value, or who are seeking location for new business enterprises. It is the principal point on the Rideau canal (slack-water, and navigable for steam vessels only) between its termini at Kingston, on Lake Ontario, and Ottawa City, on the Ottawa river. It has thus cheap water communication with Montreal for seven months in the year. There is a fall of 30 feet in the Rideau here, and at a mile below, of 10 feet, thus ensuring fine water-power. The Canadian Pacific railway runs through the town, and, by a vote of the people last week the divisional point of junction of this road and its new air line between Toronto and Montreal is secured. This last bit of enterprise on the part of the Smith's Falls people cannot fail to give their town an immense impetus forward. The population is now about 3,000; there are several foundries, flour and saw-mills, sash and blind factory, bolt factory and other industrial works already in active operation; the town is well lighted with electricity, has a steam fire engine, is well side-walked, and is always dry and clean on account of its favorable position on a side-hill and the nature of its soil which provides good natural drainage. It is perhaps without a parallel in its record of deaths at extreme old age. Deaths of people under seventy are rare, and octogenarians are of too common occurrence to excite comment. A healthier location cannot be found anywhere.

Now that Smith's Falls has become a prominent railroad center, it is sure to advance rapidly, and there is room for some enterprising Yankees to go in and "annex" the town. Water-works are needed badly; a good hotel has never been known in the place; the markets are wretched; merchandising is hardly yet understood by the stay-at-home conservative traders; there is not a single house for rent in the place, and the local builders take a year to finish one small house, hence a building contractor or two could find business, and with him, masons, bricklayers, carpenters and painters. Small manufacturers would find water-power or steam power cheap and the location an excellent one for the distribution of goods. Taxes are low, the cost of living is low, and crime is unknown.

Preparatory School Education.

In this age of universal education and continually increasing specialties of vocation, it becomes a matter of great importance that the student should have a programme of studies that will provide him with the best weapons for taking his part in the "struggle for existence." In every profession and calling, men are bitterly complaining that their education was not in more practical lines—they find themselves as but half equipped, and, though natural ability and energy may help them over their difficulties, the deficiency is none the less felt when what might have been a work of ease becomes one of strain and labor.

The Union of German Civil Engineers appointed a committee some time ago to consider "the question of preparatory school education for the higher scientific careers." The committee has just given in its report,—leaving aside its local references to the three classes of higher schools in Germany—the *Gymnasium*, the *Real Gymnasium* and the higher *Real Schule*, the recommendations are ones that might very profitably be followed here so far as their general tenor is concerned.

The committee "disclaim any intention of denying the high value of the so-called classical studies for general culture—we believe, on the contrary, that a thorough knowledge of classical antiquity and literature is highly adapted for developing the intellectual qualities in the best way." But they contend, and justly, we believe, that the grade of excellence attained by the vast majority of students of Latin and Greek is not such as to confer these advantages, and that very few indeed pursue these studies after leaving college. The question of classical studies is now being very warmly discussed in England and France. A professor in the Sorbonne lately wrote a fierce attack on Latin—tabooing it altogether. This is undoubtedly an extreme view, but it may be said that the proverbial French ignorance

of all modern languages except their own was a great part in the disasters of France.

We think ourselves that a fair "smattering" of Latin and Greek would be found of great value for every man requiring or desiring a liberal education. Such a programme, for instance, for Latin, would be filled by a good knowledge of the Eneid, a few of the books of Livy, and a few of the orations of Demosthenes. In Greek, the dialogues of Lucian and a few of the books of the Iliad. Even such a short course would be of inestimable value in conferring an etymological value of English in giving a key to the thousand and one new words that have to be coined every year for the scientific and industrial movement of the world. The mental training acquired by grasping and translating the above can hardly be otherwise procured, and would go a great way to giving that limpid thought and chiselled style that are characteristic of such classical scholars as Mr. Gladstone.

The German committee state, however, that "their *gymnasiums* are unfitted for giving a majority of their pupils a proper preparatory education for their future calling in life."

But while there is this danger of spending too much valuable time in studies of secondary importance, there is the greater loss of neglecting most essential aquirements. In this crowd of matter, something must go to the wall. The report says "Undoubtedly a knowledge of English and French, of Mathematics, Drawing, and the Natural Sciences will be far more serviceable than Latin and Greek to a child of this age that is so remarkable for the stupendo s progress of the natural sciences and their use in the development of *technique* and the almost unlimited communication of country with country both by land and sea. And that which is so indispensable to the future merchant or manufacturer, is it not also to the future physician, judge, preacher or professor? He is in future not only physician, or judge, but above all a man and a citizen, that is to live with and among other men, that must understand their ways and doings, and do good to himself and to others. And can he dispense with a knowledge and a comprehension of the present in his calling? Unquestionably the English and French technical literature of the present day will offer him a richer well of knowledge than all the old medical authors combined." The committee lay it down as the keystone of the question that the German civil engineer requires the same education and is willing to be judged from the same point, so far as general culture is concerned, as men of other avocations where high scientific acquirements are necessary.

A sufficient knowledge of French and German would be very desirable for an engineer, and by keeping his studies confined to works on his profession he might be able to read French sufficiently well after a few years study—he could not attain a knowledge of the finer shades of the literary language or use it conversationally within that time. It would be a far more difficult matter to acquire a serviceable knowledge of German. One of the German professors in the French University stated that he never knew one of his pupils to obtain a good knowledge of it unless he had had unusual opportunities and gave it much study in early youth. The more special studies of the engineer are so clearly defined that we need not refer to them here. Not to attempt too many things and yet to do well as many as possible should be the programme.

EAU CLAIRE, WIS.—The contract for the construction of sewerage in the business portion of the city, which embraces about a mile in extent, has been awarded to Fox & Hoysson for the sum of $7,600

Tunnel Ventilation.

The list of fatal accidents on the works of the New Croton Aqueduct grows longer. On Tuesday two workmen died from congestion of the lungs due to inhaling the smoke of blasting cartridges in the shaft No. 23 of the new Aqueduct, and another man is still in serious danger from the same cause. On page 344 *ante* will be found an article on this subject of the "Ventilation of the New Croton Aqueduct" based on an official report of the State Board of Health, in which the great lack of ventilation and other sanitary precautions are shown. In ENGINEERING NEWS, May 3, 1884, page 217 may also be found an abstract of a paper upon the "Advantages in Long Tunnels of Three Separate Openings, from a constructive point of view, for Ventilation and for Working." In a Report of the Royal Commission on Accidents in Mines just published by the British Government after seven years of investigation by very eminent men, the following assertionis made: "Volumes of air sufficient for the ventilation of even the most extensive collieries (or tunnels) are capable of being passed through the workings by means of properly constructed furnaces, or by mechanical contrivances, such as are already in action at most collieries."

The *Times* says of the above accident:

The history of the suffocation of these men shows that since the beginning of the work on the aqueduct, little, if anything, has been done to protect them from the noxious gases generated by the explosions in the tunnels. * * * The symptoms were distress at the chest, cramps, and vomiting. He voided nothing and his throat was contracted. * * * They both took their first shift at 7 P. M. Monday and worked until 7 A. M. yesterday. When they came out of the shaft they staggered and were very weak, and Fitzgerald "panted like a dog." At Burke's they were seized with the same sickness as Ryan, and the same remedy was administered to them. The physician in the contractors' employ did not call until 10 o'clock. * * * * * *

One of the most intelligent of the miners at Burke's said: "All hands are sick that way if they get a dose of that smoke. Not only greenhorns but old stagers catch it. No one gets so used to it but what he catches it. Sometimes it's so thick you can cut it with an axe, and it's not rare to see half a dozen men go staggering out of the shaft at a time. It's the same in all the shafts, and the trouble is want of ventilation. They treat men caught like those poor fellows to-day as for pneumonia. If Ryan and Fitzgerald had had proper treatment they would be alive now." The truth of this statement was proved by Philip Hutton, of No. 333 East Thirty-first street, New York, and John Grady, of Bloomsburg, N. J., boarders at Burke's, who are convalescing from asphyxia produced by smoke in the tunnel of shaft No. 23, and it was said that several other men in a similar condition are in the other boarding houses. Dr. Sargent learned enough while he was at Burke's to order a Coroner's investigation.

There is no excuse for the lack of ventilation of the Aqueduct tunnel, and there ought to be authority *somewhere* to enforce suitable measures for the protection of the workmen.

PERSONAL

M. HENRI GERARDIN, a leading Panama canal contractor, died at Panama recently of yellow fever, at the age of 38 years.

THE headquarters of Alsen's Portland Cement Works are now in the Post Building, 18 Exchange Place this city.

MURRAY HARRIS has been appointed Chief Engineer of the Brenham & Brazos Valley R. R. in Texas, and work will be commenced shortly on the surveys.

L. L. COPPEDGE, Chief Engineer of the Ottawa, Osage City & Council Grove R. R., was killed June 9, by the ditching of a train on that road near Osage City, Kan. MR. EVANS, a surveyor of Burlingame, was also killed, and W. L. SPENCE, a contractor, injured.

THE American Engineer, Twiddle, (?) has been appointed advisor for the development of the petroleum region, recently discovered near the Red sea in the Soudan.—*Free Press.*

JOHN FOX, 160 Broadway, N. Y., has been appointed selling agent for the Mellert Foundry and Machine Company, Manufacturers of Water and Gas Pipes, Reading, Pa.

CAPT. M. H. ADAMS, of the Corps of Engineers, and Capt. D. A. LYLE, of the Ordnance Department, who represented the Army at the Italian experiments at Spezzia, in April, have returned on the "Aurania."

MR. DUNBAR JENKINS, late Principal Assistant of the Susquehanna & Schuylkill river bridges (B. & O. extension), has been appointed engineer-in-charge of all work connected with the bridge over Missouri river at Kansas City for the C. M. & St. Paul R. R.

CARL BERRER, Assistant U. S. Engineer, was killed June 8th while in the discharge of his duties on the dredge "Froeport," at work in Portland, Me., harbor, by the breaking of the hoisting chain, one end of which struck his head, crushing in his skull, from which he died twelve hours after. He leaves a widow and four children in very straightened circumstances.

THE widow of JAMES LINTON MORRIS, the Division Engineer who was killed on the new Croton Aqueduct, September 24, 1885, has been awarded a verdict for $3,300 against the contractors Brown, Howard & Co. This is the first verdict for a plaintiff in an action for damages against any of the new Croton Aqueduct contractors.

THE following gentlemen having passed the necessary examinations, are gazetted as Dominion land surveyors: J. M. Briggs, Connington, Ont.; A. G. Finlay, Lachute, Que.; F. X. Laford, L'Islet, Que.; V. M. Robert, Toronto; W. R. Burke, Ingersoll, Ont.; K. Gamble, Winnepeg; B. Bourgeois, Becancour, Que.; C. F. Aylesworth, Jr., Madoc, Ont.; J. E. Methot, Gentilly, Que., and W. J. Deans, Oshawa, Ont.

FRANK L. SIZER, C. E., of Helena, M. T., has been appointed Engineer of the Empire Mining Co., Limited. He will have charge of all the works of the company at the Empire and Whippoorwill mines and will occupy the position of general superintendent. The Helena *Herald* says: "The company has made a good choice and is to be congratulated on securing the services of so competent a man, while Mr. Sizer's accession to such a post will be good news to his numerous friends, who will be glad that the abilities of the young engineer were so gracefully recognized."

J. WREY MOULD, a well known New York architect, died in this city on the 14th. He was born at Chiselhurst, England, in 1825; was a pupil of Owen Jones, a celebrated English architect, with whom he was associated in the decoration of the Crystal Palace of 1851. MR. MOULD came to New York in 1853, and in 1857 he became the Assistant of Calvert Vaux, then Chief Architect of the Department of Public Works. In 1870 he succeeded to Mr. Vaux's position and retained it until 1847, when he went to Lima, Peru, to execute some architectural work for Henry Meiggs. The latter's death and the war between Chili and Peru caused MR. MOULD's return to New York. He was at once engaged by the Park Commissioners to design the architectural features of Morningside Park. Central Park was the scene of most of his labors. The terrace was his principal work. He spent five years upon it. He also designed the Bow Bridge that crosses the lake and leads to the Ramble. He furnished the sketch for the present tomb of Gen. Grant, and furnished designs for a permanent tomb, the cost of which was estimated at $5,000,000.

ISAIAH SMITH, who died recently at Newark, N. J., at the age of eighty-four years, was one of the pioneer contractors of Essex county. He was born on Schooley's Mountain, near Hackettstown, and learned the business of his father, who was at that time the most extensive carpenter and builder in that section of the State. He early showed a proclivity for extensive contracting and boldly struck out into the arena of "Public Works," which was just opening up in the country at that period. His first work was to build the bridges and lay the rails on the Camden and Amboy Railroad. Then he built all the bridges, locks and planes on the Morris canal, laid the rails on the New Jersey Railroad from New Brunswick to Jersey City, and after the grading he put in entire working order the Morris and Essex Railroad, built the Newark and Jersey City plank road and, in short, was identified with every public work of the State. The many other railroads that he built in various States would take too much space to enumerate. It is sufficient to say that he was identified with all the earlier railroads of New York, Pennsylvania, Ohio, Illinois, Michigan, Connect-

ticut, etc. He was the associate of Major Beach, Bishop add other noted contractors of the day. At the stagnation of railroad building in 1838, he embarked in the coal business with Mr. Charles Fowler, under the firm name of Smith & Fowler. He retired from that firm some ten or twelve years ago, and has not been in active business since, with the exception of holding the position of Inspector for the Water Board some two or three years. "Railroad Wrecking" seriously impaired the fortune that he had accumulated, having had his investments in stocks, bonds, etc., of the different roads.

J. DUTTON STEELE died at Reading, Pa., June 13. Mr. Steele was for a long time connected with the Philadelphia & Reading Railroad, finally becoming Chief Engineer and Vice-President. In 1865 he retired from the latter position and was chosen President of the Sterling Iron and Railway Company, of New York, removing to Brooklyn. Later he returned to Pottstown, and nine years ago established a foundry and machine shop at Reading with his sons as partners.

David Van Nostrand.

DAVID VAN NOSTRAND, the well known publisher of military and scientific books and importer of foreign works, died at his residence in this city, No. 23 West Twentieth-street, a few days ago, of a complication of diseases. He had been unable to attend to his business for a year past, and his health began to fail four or five years ago. Mr. Van Nostrand was born in this city in December, 1811. In 1826 he entered the bookstore of John P. Haven, at John street and Broadway, where he remained eight years. He then associated himself with William B. Dwight. The partnership was dissolved in 1837, and Mr. Van Nostrand was afterward employed for some time by Gen. J. G. Barnard, then directing the construction of the fortifications at New Orleans.

Mr. Van Nostrand's tastes were literary and scientific, and his contact with military and professional men gave him the opportunity to indulge them. So many gave him orders for books, relying upon his good judgment for their selection, that he found the matter growing on his hands. He opened a store at Broadway and John street, opposite to that in which he had been first employed. His place rapidly became the resort of military and scientific men. During the war his military publications were numerous. After its close his specialties were scientific and foreign books. In 1869 he removed his business to its present location in Murray street. Mr. Van Nostrand had been an active member of the Union League Club since its organization, and was also a member of the Century and St. Nicholas Clubs. He was twice married, and his second wife survives him. He leaves no children.

American Society of Civil Engineers.

The Society met at 20 o'clock on Wednesday, Col. W. H. Paine in the chair. John Bogart, Secretary.

A paper on "The Water Supply and Sewerage of the Lawrenceville, N. J., School" was read by Mr. F. S. Odell, M. Am. Soc. C. E., and afterwards discussed. The Secretary again announced that the special train for the Convention will leave the Grand Central Depot at 10 A. M., June 29.; and described the proposed itinerary of the trip and the excursions to be made from Denver by invitation of the different railroad companies, which excursions will be free of expense.

The next meeting of the Society will be held on the first Wednesday in September.

St. Louis, Kansas City & Colorado R. R.—Ground was broken and work commenced at Union, Mo., June 10. It is expected to be completed thence to St. Louis and be ready for traffic before the winter. Col. Frank Anderson is the contractor.

CORRESPONDENCE.

List of Engineering Schools.

EDITOR ENGINEERING NEWS:

Will you kindly insert in your paper the following notice?

Any one who will send to the Secretary of the Rensselaer Society of Engineers, 405 Broadway, Troy, N. Y., as complete a list as possible of all the schools, colleges and universities of the United States and Canada, in which civil engineering is taught, will confer a great favor upon

A MEMBER OF THAT SOCIETY.

The Prismoidal Formula.

DICKINSON'S LANDING, ONTARIO.
June 9, 1886.

EDITOR ENGINEERING NEWS:

In your article on "The Prismoidal Formula" in the issue of June 5th, there is one paragraph which I think will lead to error in the computation of Earthwork.

I refer to that in which you recommend the actual measurement of middle sections in the field, or if the sections are taken at a uniform distance apart, *the use of each alternative section as a middle section.*

The cross sections are usually taken in the field at such distances that the intervening solid approximates, as near as the eye can judge, to a prismoid; and supposing them to be taken at equal distances apart; if two adjacent prismoids are taken as *one* solid figure, there is very little probability of its being a prismoid.

Let us suppose levels have been taken at 100 feet apart on a level railway cutting, 20 feet base and slopes of one and one-half to one. Cross section No. 1, shows a cut of 10 feet, No. 2, 8 feet and No. 3, 12 feet.

The true quantity by prismoidal formula between these three cross sections is 2422 2 cubic yards. Whereas if you apply the method recommended in your article, the quantity only amounts to 2259.2 cubic yards. For this reason I think it good practice, after taking the cross sections carefully in the field, to consider each solid between adjacent cross sections as a prismoid, and if time is given *calculate* the middle section on prismoidal lines; if not, use one of the many tables of quantities giving a good approximation to the Prismoidal Formula. Yours truly,

G. E. ROBERTSON, B. A. Sc.

[If the surface of the ground, in the given numerical example, is a true plane from section No. 1 to No. 2, and also another plane from No. 2 to No. 3, the quantity 2422 cubic yards is correct, but if we suppose, as seems most natural from the given data, that the surface is a curved one of a conic kind, then the second quantity is the correct one. As a matter of fact it would be rare to find two adjacent solids, with center cuts of 10, 8 and 12 feet, bounded by true surface planes in the manner supposed, but the profile connecting the three stations would be curved downward. It is one of the advantages of the prismoidal formula, as we pointed out, that it applies to such curved profiles if only the middle section be known. A "prismoid" in fact is not necessarily a solid bounded by planes, but its surfaces may be curved as well, and it is this property which renders the formula of such general applicability. But in a curved profile the middle section cannot be computed, but must be measured in the field. In this connection we refer to a problem on earthwork computation in our issue of May 2, 1885.—ED. ENGINEERING NEWS.]

Charleston Harbor Improvements.

PHILADELPHIA, June 12, 1886.

EDITOR ENGINEERING NEWS:

As you have called attention in your issue of this date to Gen. Gillmore's reflections upon my veracity of purpose, I trust that in justice to me you will now publish my reply which was written and sent to the *Tribune*, June 4, but which I have not yet seen in its columns. I think this due me, especially as Gen. Gillmore has written me stating that if he had seen the amended paper of the proceedings, he would not have written his communication.

This is the substance of my reply to the *Tribune:*

In your issue of the third inst. occurs a communication from Gen. Q. A. Gillmore opening with this sentence which I heartily endorse: 'The professional statements of an engineer should rest upon a solid basis of truth; with any other foundation than this the superstructure is not worthy of trust.' He then adds: 'This maxim appears to have been overlooked in a remarkable manner by Prof. L. M. Haupt, Civil Engineer, in a paper entitled Harbor Studies read before the Engineers' Club of Philadelphia, on the 16th of last January.

This opinion is based upon an extract from my paper, which Gen. Gillmore quotes later, as follows: "And at the completion of the work, we find from the report and maps of 1884," etc. He lays stresses upon the words, "*at the completion of the work*" taken by themselves, and then cites facts to show that the work was not completed at that date. In the closing paragraph he adds that my opinions "necessarially carry some weight which ought not to be thrown on the wrong side through misstatement or suppression of fact."

These assertions coming publicly from so eminent a source are of such a character as to merit a brief reply. The General has simply misconstrued my meaning. * * * The term "completed" was used in the sentence quoted in the same manner as it is used to express the condition or stage of the work in any progressive or continuous operation or course, that is, as indicating the state of the work at a specified date, which I gave as 1884 or that of the latest reports available. In revising the advanced sheets of my paper for publication in the proceedings of the Engineers' Club of Philadelphia, Vol. V., No. 4, fearing lest this clause might be misunderstood, I amended it to read: "And *at this stage* of the work, we find," etc. It is in this form that it goes on permanent record. It is not always possible, however, to be thoroughly guarded in the collateral issue of an extended discourse and even in the opening paragraph of his communication, I believe the General makes a statement as to the responsibility for the expensive *methods* of constructing works resting upon Congress, which will be misconstrued. He says, "Considerable newspaper discussion has been indulged in from time to time with respect to the works for the improvement of the entrance to the Charleston Harbor, now in process of construction under the expensive methods enforced by Congress," from which it might appear that the legislative had usurped the functions of the executive department of the Government.

As my paper treats of methods of improving harbors, it necessarially refers to the theoretical and practical objections to the system of submerged jetties as attempted to be used at Galveston and Charleston. As I believe such structures to possess inherently the elements of their ultimate destruction, I am compelled to oppose them, on principle. This I do without personal opposition to those colleagues, eminent in the profession, whose duties may require them to make a practical test of theoretical methods, for an argument that is based upon personalities only must *ipso facto* be one destitute of merit as to facts.

LEWIS M. HAUPT.

UNIVERSITY OF PENNSYLVANIA, June 4, 1886.

Charleston Harbor Improvements.

To the Editor of the Tribune.

SIR: The professional statements of an engineer should rest upon a solid basis of truth; with any other foundation than this the superstructure is not worthy of trust. This maxim appears to have been overlooked in a remarkable manner by Professor L. M. Haupt, civil engineer, in a paper entitled "Harbor Studies," read before the Engineer Club of Philadelphia, on the 16th of last January. Considerable newspaper discussion has been indulged in from time to time, with respect to the works for the improvement of the entrance to Charleston Harbor, now in process of construction under the expensive methods enforced by Congress, and Professor Haupt directs his attention in part to that locality.

The plan of improvement consists essentially in building two jetties or training walls, starting respectively from Sullivan's island on the north side and Morris Island on the south side of the entrance, and converging toward each other on curved lines in such manner as to cross the bar on parallel lines, with a clear distance of half a mile between them. The Board of Engineers appointed in 1878 to consider and report upon this plan expressed this opinion:

> The channel over the bar can be improved to a probable low water depth of 21 feet by the use of jetties submerged in whole or in part and by a mode of construction very gradual in its progress, which will admit of such modifications in the lengths and heights of the jetties as experience shall dictate * * * According to the extent of the project which may be adopted the cost will be from $1,800,000 to $3,000,000.

The larger project is the one under execution, as stated in the annual reports, and the lengths of the jetties have been, and the heights will be, adapted to it. Professor Haupt, after making the foregoing quotation from the report, adds: "And at the completion of the work we find from the reports and maps of 1884, that the present shoalest soundings along the channel at mean low water are 12 feet," and that "instead of 21 feet, the figures are reversed, and a half a foot of water has been lost." The foregoing, it must be remembered, is stated to be the condition of things "at the completion of the work." Now the facts are briefly as follows:

1. The works as originally designed were only about one-third done, and a trifle more than one-third of their estimated cost of $3,000,000 had been expended upon them at the time mentioned by the Professor. To be more exact the sum expended amounted to $1,099,769.

2. No portion of either jetty had yet reached the height contemplated in the project, the average deficiency amounting to many feet, and on one section of the south jetty to more than 20 feet. The average height attained by the north jetty was only 4 feet, while the total average height required is 10 8 10 feet, leaving 6 8-10 feet yet to be added. The south jetty had reached an average height of only 3 4-10 feet, while a height of 12 feet is required by the original plan. Its crest therefore had yet to be raised 8 6-10 feet. The work done previous to the time selected for the Professer's criticism was in fact never considered to be much more than a foundation course.

3. The contraction of water-way necessary to be secured by the jetties had reached only about one third the degree of contraction which the plan contemplates, in order to develop the scouring currents require to maintain the new channel.

There are other points in the Professor's paper to which grave exceptions might well be taken, but they will not be discussed here or now, as the sole object of this letter is to prevent mischief and confusion of opinions at this time, when the improvement of our important harbors demands the unbiased attention of our National Legislature. The views of Professor Haupt, who is a graduate of West Point, and is now at the head of the department of civil engineering in a university, necessarily carry some weight, which ought not to be thrown on the wrong side through a misstatement or suppression of facts. Q. A. GILLMORE.

NEW YORK, June 2, 1886.

Flood Rock Dredging Operation.

ENGINEER OFFICE U. S. ARMY, ARMY BUILDING,
NEW YORK, N. Y., June 9, 1886.

EDITOR ENGINEERING NEWS:

My attention has lately been called to two short articles in recent numbers of ENGINEERING NEWS on the subject of the work at Flood Rock.

One of these articles based upon statements made in one of the daily papers, says that one of the dredges is removing the rock at the rate of "three or four scow loads per day, of about 230 tons each;" and the other, on the authority of Mr. J. H. Staats, the superintendent for one of the dredging companies at work, states that "the Hen and Chicken is not broken up at all from the original blast."

As these two accounts differ rather strikingly and are both very far from the truth, I send you a correct statement of the progress made on Flood Rock since the blast up to May 1st, and a sketch showing the reef known as the Hen and Chicken, which Mr. Staats says was not broken at all.

The soundings shown were taken immediately after the blast, while the contour lines give the surface of the reef as it was originally. A close inspection of this sketch will show that the entire surface of the reef has been changed, in many cases as much as ten feet vertically.

On the southern end of Flood Rock proper, which is bare at low water, where it can be plainly seen that the rock is thoroughly broken, the vertical changes are no where greater than on the Hen and Chicken.

Mr. Staats thought the rock was not broken because, at the time he wrote, *his* dredge was making very poor progress compared with the other two. He did not give sufficient consideration to the fact that the latter were veteran rock diggers, while his men were entirely inexperienced at this kind of work, and the machine itself had only just been fitted up for it and was constantly breaking down. Since all hands have acquired some experience, and certain alterations have been made in the machine, I find her record compares well with that of the others, being something over sixty-five tons per day for the month of May. The following table gives the records of all three machines up to May 1.

Number of Dredge.	Size of Engines.	Weight of Grapple.	Span of Grapple.	Locality on Reef.	Began Work.	Suspended on Account of Ice.	Number of Working Days on Reef.	Number of Hours Worked.	Number of Surface Blasts Fired.	Number of lbs. Dynamite Fired.	Number of tons (2,240) of rock raised.	Average Tons per Working Day.
1	26" × 24"	14 tons	17 ft.	Negro Heads.	Nov 10, 1885.	Jan. 16 to Feb. 16, Mar. 3 to Mar. 10.	116	908	67	5130	9330.8	80.44
2	20" × 20"	8 "	9 "	" "	Nov 13, 1885.	Jan. 11 to Feb. 24 Mar. 3 to Mar. 10.	99	823	50	2719	5071.5	51.23
3	18" × 24"	13 "	11 "	Hen and Chicken.	Feb. 23, 1886.	Mar. 4 to Mar. 9.	57	336	31	2700	1791.6	31.43
Totals							272	2066	148	10549	16193.9	

To show how thoroughly good the above results are, it is only necessary to say that the dredge designated as No. 1 above, did the bulk of the work on Hallet's point, and her average progress from March to August, 1878, was only 50.4 tons per working day. It is also interesting to note in this connection that the price paid was only $2.29 (the United States doing the surface blasting).

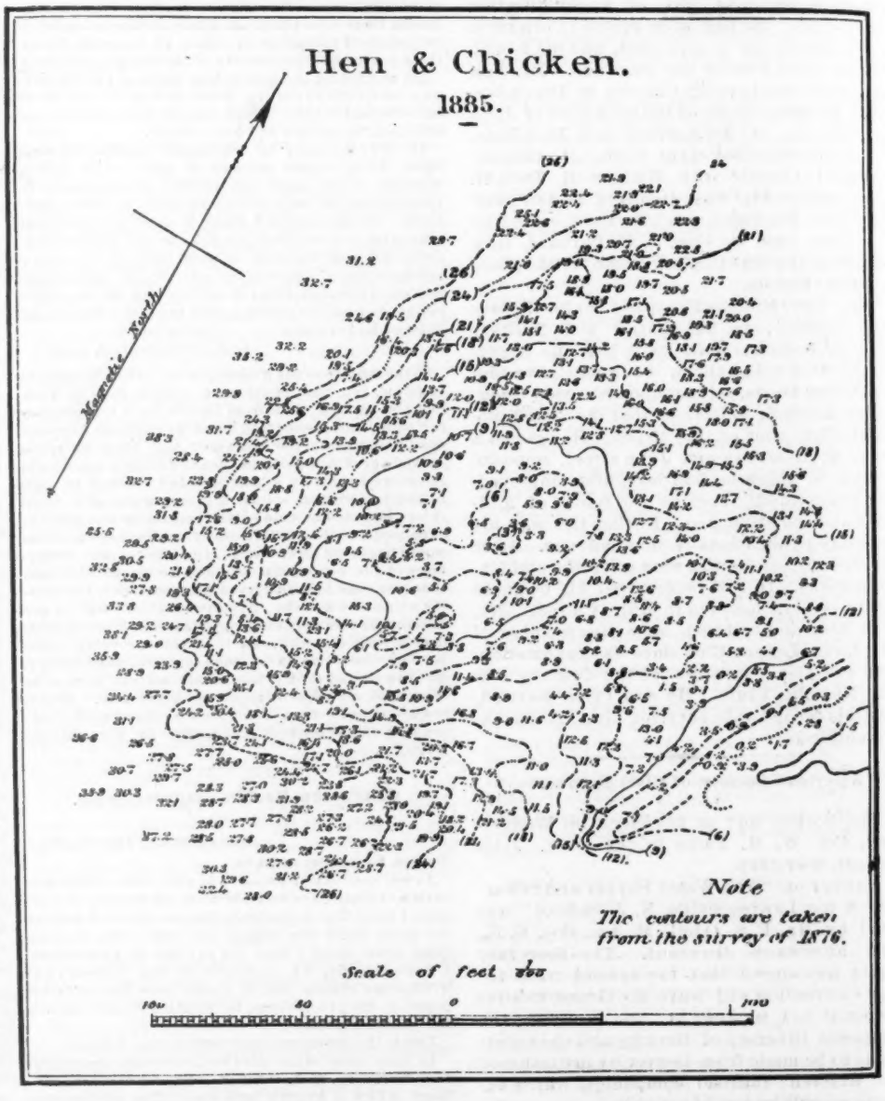
This matter of surface blasting has been grossly exaggerated, it having even been stated that all the rock so far removed was broken by the surface blasts; whereas, the fact is, that the cost of all the surface blasting done up to May 1st, amounts to a little less than 14 cents per ton of rock removed, and for the month of May it is only 10.2 cents per ton. The blocks on the surface of the reef are very large, as one would expect them to be when it is remembered that the average thickness of the roof was over 18 feet and that all the drill holes were in the lower 7 feet of this thickness. To have put in powder enough to blow the surface into small pieces, would have been as extravagant as it would have been dangerous.

The amount of surface blasting required decreases rapidly as the work progresses, but it has at no time been excessive as plainly shown by its cost. It had to be done at Hallet's Point at first just as it is being done at Flood Rock, notwithstanding the fact that the space excavated below the reef was 2.7 times greater per cubic yard of rock broken by the blast, which by allowing large masses to fall, assisted much in opening out the surface. Flood Rock has now been attacked in four different places, and so far from any exceptional difficulty with the dredging having been encountered, the progress made has been unprecedented, a fact that ought to be recognized.

The present contract is for the removal of about 30,000 tons of rock and the amount removed, June 1st, is 21,500 tons, so that the time for letting a second contract is rapidly approaching.

Mr. Staats, the superintendent for one of the contractors who signs the letter in your issue of April 10th, was doubtless governed by a proper motive, but if such statements are left unanswered it is easy to see that many would-be contractors might be frightened off by the exaggerated difficulties and the government would lose the advantage of the competition amongst the bidders.

Very truly yours,
GEO. MCC. DERBY,
Lieut. of Engineers U. S. A.



Illinois Ditching Trial.

Specially reported for ENGINEERING NEWS.

A tile ditching machine contest took place on the farm of the University of Illinois, at Champaign, on June 10th and 11th, under the direction of the State Board of Agriculture. The interest was very great and the attendance quite large, probably not less than 1,000 to 1,200. Many practical farmers and large land owners were present from all parts of the State. A number of civil and mechanical engineers were in attendance. Judging from the interest manifested and from the conversation of those in attendance, tile drainage is even yet in its infancy in Illinois. It was currently reported during the contest that there are a million miles of tile yet to be

laid in that State. It is held that if a satisfactory machine for laying the tile can be found, the number of tile laid per year will be greatly increased. The first cost of the tile has been so greatly reduced in the past few years, owing to improvements in the process of manufacture, that it only remains to find some cheaper means of laying the tile. At present it costs 30 to 40 cents a rod, wholly by hand.

The machines present claimed to be able to do the work for 5 to 8 cents per rod. The importance of saving 75 to 80 per cent. of the cost of laying is easily seen.

There is no good reason why the trench should not be opened by horse or steam power, and after the tile is laid, the earth thrown into the ditch by the same power. Possibly a machine could be made which should do all the work at a single operation, but at present it is held that an opportunity should be given for inspecting the tile before filling the trench. The principal object of the contest just closed was to stimulate the development of tile laying machines.

Five machines entered for the contest, but only three put in an appearance. Of those present the oldest machine is that made by the Plumb Ditching Machine Co., of Streator, Ill. It is a steam machine; the engine, boiler and digging parts rest upon a wooden frame 6×15 feet, and runs on four wide wheels. The digging is done by means of scoops on the circumference of a wheel 9 feet in diameter, revolving so that the scoops or shovels gather earth when coming upwards. It cuts a trench 10 inches wide, with a maximum depth of 52 inches. It grades and finishes the ditch as it goes. The grade is kept by a screw adjustment and a line of targets ahead. The machine is moved forward as the work progresses by a cable which passes over an anchor ahead and is wound on a drum by the driving engine. It has a capacity for about 100 rods per ten hours, although under favorable conditions it can double that rate.

Chandler & Taylor, Indianapolis, Ind., exhibited a machine. The digging part consists of an endless chain or succession of U shaped buckets, running over an arm, the corner end of which runs upon the bottom of the finished ditch, the upper end being carried upon a pair of wheels which are hitched behind an ordinary portable engine. The machine showed a capacity of 125 rods per ten hours. This machine, as well, in fact, as all tile ditching machines, is propelled forward by the cable and anchor as described above; this method is supposed to be necessary in order to keep on line.

A Chicago firm exhibited a machine with essentially the same cutting device as the Plumb machine but was driven by a circular horse power. This is a new machine, and broke down after an hour's work.

The two machines first mentioned seemed to be very evenly matched. The committee made a very thorough test, the result being that the two machines were rated nearly equal in every particular. The final result was 747 points for the Indianapolis and 743 for the Streator machine. The former therefore will receive the gold medal.

While it was conceded with great unanimity that all three machines worked successfully, yet there was a marked feeling among the farmers that the problem of how to dig a tile ditch in the best way has not been solved. The two machines which were in working condition cost about $1,200, which is beyond the reach of the ordinary farmer. The manufacturers only intend them for large land owners, or contractors, who will go about over the country doing work for the farmers. Naturally enough, and possibly mistakenly, the farmers want a machine which shall come within the reach of the ordinary land owner.

Incidentally a contest was held for hand ditchers, the prizes being $20, $10 and $5, with a consolation purse of $20 to the losers, speed and style considered. There were eleven contestants, some of whom came 100 miles or over. This formed a very interesting part of the contest. The skill displayed was surprising. The average time for opening a dry ditch 3 feet deep, 4 rods long, for a 4-inch tile, was one hour, thirty-seven and two-thirds minutes. The grade of the bottom was of nearly mathematical accuracy, the walls were as plumb and straight as the side of a house, the width of the ditch was about 6 inches at the top and 4 at the bottom. The only tools used were two sizes of spades, and a scoop for cleaning out the bottom, the grading being done by eye. There are many points in favor of the Armstrong machine, the only one against it being cost.

Within a few days a committee will visit the dredger operating in the different parts of the State, and award the gold medal for the best method of excavating large open ditches.

River and Harbor Improvement.

Views of Col. Craighill Continued—An Important Suggestion.

BALTIMORE, MD., June 10, 1886.

Proprietors of the Sun, Baltimore, Md.

I feel that I have already unreasonably trespassed upon your patience and taken too much of the valuable space of your paper, but I hope to be excused for a few more words in this final letter.

In the last communication something was said as to the improvement of rivers and harbors by the United States. If this work should be given up by the general government recourse would be had to the states themselves, or to the agencies of the corporations and individuals, acting through charters granted by states. I refrain from elaborate discussion of this method of doing an important public work. It is open to several objections, which will not be specified here. One may be mentioned. A waterway is a highway given by nature herself, which should be free to all the people, and not brought under the influence of politicians or monopolists. This theme might be much dwelt upon, and with profit, but it is here simply suggested.

It is often assumed that much opposition to river and harbor bills comes from some of the railways. This opposition undoubtedly does exist to a large extent, and it is not to be wondered at when we recall to mind, as a single illustration, the effects upon freights produced by the closure by ice of the Erie canal and its continuation to New York, the Hudson river, and by their re-opening in the spring. But it is unfair to conclude that railways and rivers are natural enemies. One of the ablest men Baltimore has produced was of a very different opinion, I refer to Mr. John W. Garrett, whose friendship and esteem I had the pleasure to retain for a number of years before his death.

Let me illustrate the statement I have made by some facts concerning the Chesapeake and Ohio Railroad. That important road, as well known, is for many miles built along the banks of the New and Kanawha rivers in West Virginia. It first touches the New river at Hinton, which is one of the most important stations between Staunton and the Ohio river. The New river rises in northern North Carolina and flows northerly through Virginia, through a most beautiful and picturesque country, full of minerals and admirably adapted to agriculture and grazing. The record in 1882 was that 92 per cent. of the freight sent from Hinton by rail came down New river in boats to Hinton, and 43 per cent. of the freight received by rail at Hinton went up New river in boats.

The United States work on the Great Kanawha river, though as yet unfinished, has caused a very great development of the coal interests on that river. The shipments by the river of that great staple of industry have very largely increased, but the business of the railroad has also increased.

The New river is crossed at right angles in Pulaski county, Va., by the Norfolk and Western Railroad, which has its eastern terminus at Norfolk. The little improvement of this river, with small expense to the United States, has greatly increased the amount of freight for the railroad received at its intersection with it. This is also a great advantage to the producers, as they are saved much tedious and expensive teaming of heavy and bulky products. The lead mines in Wythe county, Va., have for more than a century been a locality of much interest, because it is one of the few points in our country from which that article of commerce can be had. In our revolutionary war, and in the recent civil war, the possession of these mines was an object of additional importance. At present the difficulty and expense of teaming over bad mountainous roads are great. These mines and others of iron and other important ores are immediately upon New river. If that river could be improved, as it might be at small expense, the very valuable products of these mines could be delivered in much shorter time, with much less difficulty and expense, to the Norfolk and Western Railroad or to the Chesapeake and Ohio Railroad. And yet the New river and the Great Kanawha river are the subjects of constant ridicule when the talk is of "trout streams," "mud puddles," "suitable streams for macadamizing," etc. It is because the talkers are ignorant.

Some people say the day of canals is past, but, while not going into that subject, I will only admit that some canals were improperly located, not placed in the line of traffic, and so have not been successful. Others have fallen into improper hands and been improperly managed, and so have not been successful. This is quite as true of some railroads as of some canals, but not of all of either class of public works.

Many of the smaller rivers and even creeks which enter our magnificent bay, at the head of which sits Baltimore like a queen, are comparatively insignificant in themselves, but the trade of this great bay is made up of the contributions from these rivers and creeks. The aggregate is a mighty volume. Is not this volume a subject of national importance? Where is the line to be drawn which will lessen it by cutting off any part of it from the fostering care of the government?

We hear much about "pork" and "boodle" in connection with river and harbor bills. I know little or nothing of the methods of politics, but I think it is discreditable to ourselves as a people that general charges or rather insinuations are made in this way against the Senate and House of Representatives of this great nation. If any citizen can prove that such a charge is a just one against any members of either of these bodies, he ought to make it specific as to individuals and items. So also let us have specific reasons for objections to items of the river and harbor bill. I suppose it is thought by many that "pork" for the Congressman's district influences him to act and vote for these appropriations, and it is really believed that large sums are actually used from these funds to affect elections or other political matters.

On this point I feel bound to bear my testimony, be its value what it may. I have in the past twenty years had to deal with very many works of improvement of rivers and harbors on the Atlantic coast, from the Delaware to the Savannah river, and from the Atlantic to the Ohio at the mouth of the Great Kanawha, and I can affirm there has never been a single political appointment made by me, nor a single contract awarded through political influence. If any Congressmen resort to "log-rolling" to procure these appropriations it is not because any of the money gets improperly into the hands of their constituents or other people.

Many millions of the public money have passed through my hands, and the accounts for its expenditure have been carefully scrutinized at the War Department and afterwards by the vigilant and sharp-eyed clerks in the offices of the auditors and comptrollers of the Treasury Department, and I believe they will unite with all who have any knowledge of the subject in testifying that no public money goes more directly, faithfully and economically to the objects for which it was appropriated and to the promotion of the interests of the general public than that which is spent by the War Department in the improvement of rivers and harbors.

In conclusion, I should say that the illustrations I have used are drawn from my own experience and knowledge and from my long connection with works for which Baltimore is a great commercial center. My experience is that of all other officers at other great centers of trade, such as Portland, Boston, New York, Philadelphia, New Orleans, Chicago, Cincinnati, St. Louis, St. Paul, San Francisco and very many others.

There would be a very great gain in the direction of economy of money if a different system of making appropriations for rivers and harbors could be adopted. There would, by the same system, be a much more speedy attainment of useful results. The system suggested is this: Let a suitable joint committee of Congressmen, or a commission approved by Congress, consider the whole subject; let them tabulate all the rivers and harbors in the United States; let them designate those which should be improved at the expense of the general treasury; let them arrange these into classes in the order of their relative importance; let careful projects for their improvemnt be made; let the total expense for each become known; let the whole sum for each of those selected for improvement in its order be made available, not in yearly driblets as now, but (as is done by other great nations) as rapidly as true economy requires the work to be done.

Does anyone suppose Capt. Eads would have been so successful at the mouth of the Mississippi river if money had been doled out to him as has been usual with other rivers? The important results attained there would, under the usual method of appropriations, have been realized in all probability only after many years of delay, and not nearly so speedily as we have seen, if at all.

Per contra, if there has been partial failure at Galveston, as alleged, much of it is due beyond question to the insufficiency of the occasional, intermittent appropriations for the improvement of that harbor.

Respectfully yours,

WM. P. CRAIGHILL.

NOTE.—What would be thought of a man who, with plenty of money, intending to build a ten thousand dollar house, should spend only one thousand a year on it? If ever completed, would it not be likely to cost him nearer fifteen thousand than ten thousand dollars? Moreover, he would for years be kept by such a dilatory method from the use of his proposed house. In all probability he would also find his house, after long exposure in an unfinished state to the weather of winter and summer, not nearly so good as if it had been built in one year or two years at farthest. And yet this is the method (or rather want of method) which has prevailed in making appropriations for rivers and harbors for the past twenty years.

Shreveport Water-works and Sewerage Specifications.

WATER-WORKS

(See Advertisement.)

Section 2. The said water-works shall consist of an adequate pumping plant, reservoir, two settling basins, and a general street main distribution, consisting of iron pipes, valves, hydrants, etc.

The water supply shall be taken from deep water in Cross bayou near the point designated on map, shall be first pumped into settling basins of adequate size and capacity to permit of proper settlement and filtering before being pumped into the mains. A pumping plant of at least two million gallons daily capacity shall be provided and established for this purpose.

Another pumping plant of at least two million gallons capacity daily, under 200 feet head, shall be provided and established for pumping the water from the settling basins into the mains and the reservoirs.

This pumping machinery shall be of standard make and first-class in every particular, and shall be properly set up in brick or stone buildings of proper size and form. The settling basins shall be at least two in number, of at least one million gallons capacity each, and constructed in such manner as to permit of a depth of 20 feet of water when full, with the bottom inclined sufficiently to permit of easy drainage and flushing. The sides of the basin shall slope sufficiently to insure firm standing. The bottom, sides and a margin of 4 feet in width at the surface level of the embankment shall be paved with burned brick, the brick to be laid upon the edges, truly and evenly, and bedded and jointed in good cement mortar.

These basins shall be provided with all necessary inlet, outlet and drain pipes; also with all necessary gates, gate chambers, screen chambers, filtering chambers, etc.

In the streets as shown on the map, and designated in the accompanying tables, shall be laid 6,450 lineal feet of 16-inch pipe, 8,430 lineal feet of 12-inch pipe, 3,100 lineal feet of 8-inch pipe and about 31,875 lineal feet of 6-inch pipe, in accordance with the lines designated upon the map; also 106 double fire-hydrants and thirty-seven stop valves or gates, shall be furnished and set in the positions designated. All pipes shall be laid 3 feet below the grade of the street. Pipes and hydrants shall be tested to 300 pounds hydrostatic pressure to the square inch before leaving the manufactory, and shall also be tested to 150 pounds to the square inch after being laid.

A steel reservoir of at least 250,000 gallons capacity shall be constructed at sufficient elevation to afford fifty pounds hydrostatic pressure per square inch upon the mains on the level of Commerce street, and the works shall be of sufficient power and capacity to throw six 1-inch fire streams simultaneously, to the height of 100 feet above the level of Commerce street. If a franchise is granted by the city it will be for a term of thirty years, at the expiration of which time the city, if it shall so elect, shall have the right to purchase said works. The purchase price shall be determined by appraisement in the following manner: Each party to the contract shall choose a competent engineer, and the two so chosen shall choose a third, and the three so chosen shall determine, under oath, the value of the property, and the verdict so found shall be binding upon both parties.

The party to whom the contract may be awarded will be required to proceed promptly and with all due diligence with the work to its completion, and when completed in accordance with these specifications and the contract stipulations, the liability of the city for payment for the public service shall commence.

Section 3. The following tariff of rates per annum may be charged to consumers for the use of water, and made a part of franchise under contract:

Bank, full front, $8; half front	$ 5.00
Barber shops, each chair	3.00
Public bath tubs	10.00
Bakeries, from	$8.00 to 16.00
Butcher stalls, from	$8.00 to 16.00
Building purposes, per 1,000 brick	.05
Building purposes, per one perch of stone	.05
Building purposes, per 100 yards of plastering	.30
Drug stores, full front, 25 feet or less	10.00
Drug stores, half front	6.00
Residence of four rooms and under	6.00
Each additional room	1.00
Private bath tubs	3.00
Private stable for one horse, including washing carriage	4.00
Each additional horse	1.50
Water closets, private, per bowl	3.00
Sprinkling lawns, 3-16-inch orifice, not exceeding one hour per day, per 1,000 square feet	3.00
Cows or similar animals	1.00
Swine, each head	50
Fountains, not exceeding four hours per day, 1-16-inch orifice per season	15.00
Fountains, not exceeding four hours per day, ⅛-inch orifice, per season	20.00
Fountains, not exceeding four hours per day, 3-16-inch orifice, per season	30.00
Store uses, 25 feet or less	6.50
Each additional 10 feet or less	2.00
Washing buildings and sidewalks to center of street, 3 16-inch orifice, 25 feet front or less, extra from store use	3.50
Each foot over 25 feet front per foot	15
Corner stores one half additional to above rates;	
Sleeping rooms	$2.00 to 4.00
Offices, first floor $6.00, second floor $4.00, third floor	2.00
Photograph galleries	$8.00 to 15.00
Printing offices, no engine	10.00
Engines, per horse power	2.00
School-houses and lots, 3-16 inch orifice, one hour per day, per 1,000 square feet	2.00
That for drinking purposes during the day free.	
Saloons	$15.00 to 30.00
Livery horses, including all of the similar kinds and washing carriages	2.00
Each additional stall	1.50
Urinals, public	5.00
Urinals, private	2.00
Constant flow, special rate.	
Restaurants	$15.00 to 30.00
Soda fountains, spray or washing jets, per season	6.00
Aquarium fountains, per season	3.00

USES SUBJECT TO SPECIAL RATING BY METER MEASUREMENT.

Dyeing and scouring establishments.
Foundries and machine shops.
Hotel and boarding houses.
Bottling works.
Laundries.
Sprinkling carts.
Workshops.
Breweries and distilleries.
Railroads.
Individual fire protection.
Manufactories.

In the above not to exceed 30c. per 1,000 gallons.

Section 4. In consideration to fix price in contract and franchise, contracting party will be required to supply all the water necessary for the extinguishment of fires, flushing sewers and gutters, engine houses, public parks and fountains, public schools and all other public buildings, maintain the hydrants, pipes and attachment in good order and working condition, and the head or pressure necessary for good and effective service at all times without additional cost to the city.

Section 5. Contractor or assigns shall have the right and privilege to extend the mains of various sizes when consumers ask it provided the same is laid 3 feet below grade and imposes no expense on the city. The city shall have the right to order the laying of additional mains or extensions of existing mains when the public needs demand the same and the city is able to provide for paying any additional rental, it being understood and agreed that no charge shall be fixed at a greater sum than 7 per cent. on the cost of mains and hydrants so ordered. Such extensions to be made within ninety days after contract is signed for additional appropriation.

Section 6. The city will reserve to itself the right to attach additional hydrants to any mains already operated and provided for under contract that it may deem necessary to meet the requirements of the public service, such additional hydrants to be attached and located at its own expense, and the contractor must agree to do all such work at net cost.

Section 7. The contractor or assigns shall have the exclusive right to tap the mains and to make all needful rules and regulations for the protection of said water-works and their operation in supplying consumers with water, for shutting off water, for non-payment of water rates, or waste of water, or to regulate service pipes, sizes and kinds, and all fixtures used in or outside of buildings, and to require and fix the penal sum of any bond from those who may engage in plumbing and otherwise regulate the safe and efficient operation of the water-works.

Section 8. The contractor and assigns shall provide an electric fire alarm connecting the city offices of the fire department and police station with the reservoir or water tower or pump house, so that an alarm of fire may be communicated to the engineer in charge of the works.

SEWER SYSTEM.

(See Advertisement.)

Section 9. The proposed system will consist of two main or trunk lines of sewer as indicated on the map before referred to and marked main sewer No. 1 and main sewer No. 2 respectively, and also a sub-main on lower Texas avenue from Marshall street to Commerce street, there connecting with the Commerce street main, and also a system of laterals tributary to the above named mains, which shall be adequate to meet the requirements of the entire city, and which may be developed as rapidly as the needs of the city shall call for, and the city authorities direct.

These sewers shall be of the style known as pipe sewers, and calculated only to dispose of legitimate sewerage matter—storm waters being excluded.

The pipe used shall be of vitrified clay, salt glazed made with socket and spigot joints. The size of pipe for the mains and sub-mains shall correspond with the sizes marked on the map and accompanying tables, and the sizes for the laterals shall be 6 inches throughout the entire system.

The pipes shall be laid to true line and grade, with all joints thoroughly yarned and cemented, Y branches with 4-inch openings, being provided for each lot on both sides of every line, both main and lateral.

An automatic flush tank, built of masonry, shall be provided at the upper end of every line of mains and laterals. These flush tanks shall be circular in form, of 4 feet internal diameter at bottom, and 2 feet diameter at top; shall be built up to street grade and provided with proper iron collars and covers.

Manholes shall also be provided at each street intersection of every line of main sewer, and lateral, except where flush tanks are located. The manholes will be built in the same manner, and of same size as the flush tanks, except that they will not be provided with automatic flushing apparatus.

The main lines will be laid at the depth indicated on the accompanying map and profile. All laterals will be laid 4 feet below street grade at their commencement or upper ends, and will be given all the fall that the grade of the main line to which they are tributary will permit.

The two main or trunk lines shall discharge into a properly constructed catch basin built of masonry, and provided with iron collar and cover. The catch basin shall be located at the distance of 60 feet from the river bank at the point indicated on the map. From this catch basin a line of iron pipe will lead directly into the river, discharging at a point below low water level. This iron pipe shall be at least 18 inches in internal diameter with its lower end properly and firmly secured to prevent displacement by river action.

All laterals will be run to and connected with the main to which they may be most readily accessible. All pipes must be laid to true line and grade, and the streets must be restored to as good a condition as before being opened.

Section 10. Proposals may be made for the construction of the water-works separate and distinct from the sewerage system. Also for the sewarage system separate and distinct from the water-works, or jointly for both water-works and sewer systems.

All proposals must agree to complete work stipulated within twelve months from date of contract, and must be accompanied by a certified bank check in the sum of $2,500 payable to the order of the city of Shreveport, conditioned and guaranteeing that contract will be signed by bidder within thirty days, and work commenced in sixty days, or that the said contract and said $2,500 will be forfeited to the city. The city reserves to itself the right to reject any or all bids; checks will be returned to all rejected bidders immediately after action is taken on proposals.

Section 11. When the said works are completed and the city clerk notified, in writing, the city within ten days thereafter shall make a test for assurances herein set forth; and if, upon a test, the works are in compliance as herein set forth, then the city shall, by resolution, make immediate acceptance of the same. Then thereafter for the full term of this ordinance the contractor shall continue to furnish without default a constant and uninterrupted supply of water, as hereinbefore set forth. Failing to do so, the said city may take possession, temporarily, of said works, machinery and appurtenances, and operate the same until assured that the works will be efficiently operated by the contractor or his assigns, and the expense incurred by the said city in so operating said works, shall be a lien upon the earnings of said works until paid, and shall be deducted from any sum due said contractor or assigns. Where a test is required, the city hereby agrees to furnish hose and nozzles with which to make the test.

Section 12. That for the purpose of meeting and paying the fixed charges that is named in any acceptable bid herein called for, the city will bind itself firmly by contract indissoluble and irrevocable in form and manner required by its charter and the general laws of Louisiana to protect the franchise that may be granted, hereunder, and to annually appropriate in its budget of expenses all sums that may be agreed upon as a

fixed charge or annual rental during the faithful operation of the works in accordance with contract. The city will agree to accept for all city dues the rental vouchers or any interest coupons issued by the company or contractors for any fixed charges when due to the extent of such rental.

Section 13. This ordinance shall be promulgated in the official journal of the city of Shreveport for ten days after its passage, and all ordinances or parts of ordinances and all ordinances on the same subject matter, and all ordinances in conflict with this ordinance be and the same are hereby repealed.

Passed by a unanimous vote of the board of trustees of the city of Shreveport, this 13th day of May, A. D., 1886.

WATER

CLARINDA, IA.—A system of water-works is contemplated. Raymond Lozanz, mayor.

CORNWALL, ONT.—A company purposing to build water-works is seeking incorporation.

AMERICUS, GA., is agitating the erection of water-works.

WORTHINGTON, MINN., will probably have a system of water-works. R. B. Plotts is interested.

MANSFIELD, MASS.—A petition is being circulated remonstrating against putting in water-works.

SILVERTON, COL.—The water-works are pronounced a failure as a protection against fire. Four hydrants recently lowered the reservoir to such an extent that in eight minutes from the starting time the streams thrown did not reach a height of ten feet.—Denver, Col., *Tribune Republican*.

MERIDIAN, MISS.—The proposition of George P. Anderton, of Birmingham, Ala., to build water-works at a cost of about $75,000, has been accepted, subject to certain conditions.

ROCHESTER, MINN.—H. H. Harrison, of Stillwater, has made a proposition to the City Council to put water-works into the city. His plan is to place on Bear creek a pumping station with 2,000,000 gallons daily capacity, capable of forcing water into a reservoir on College Hill. This reservoir, he estimates, will give on Broadway sixty pounds pressure and a stream 100 feet high. Mr. Harrison limits himself to three months' time, and is willing to give bonds for $10,000. The city will pay from $4,000 to $5,000 for hydrants, reserving the right to buy the whole plant, when it sees fit.

BOSTON, MASS.—MAYOR O'BRIEN has vetoed the City Council's order for the ratification of the Worthington pump contract. This contract was made by the Boston Water Board, May 19, 1885 with Henry R. Worthington for certain pumping engines and machinery. Mayor O'Brien says in his message: "There was no advertising and no competition. The pump manufacturers of this city and the country feel that they were unjustly treated in this matter, and I am convinced that such is the fact."

MASSILLON, O.—A sight draft for $50,000 was given June 7, by Samuel R. Bullock & Co., of New York, in exchange for the franchises and property of the Massillon Water Company. The new company organized by electing the following officers:—President, E. Waltman, New York; Vice-President, Col. J. Walter-McClymonds, Massillon; Treasurer, Gov. John G. Warwick, Massillon; Secretary, Hon. Ellis Morris, New Castle, Pa.; Directors, above officers and Hon William A. Schultze, Lancaster, O. The company proposes to expend about $150,000 in constructing a general water system.

SUMTER, S. C.—At the election on June 8, which was called by the Town Council to determine whether or not the town should be authorized to borrow the sum of $20,000 for the purpose of creating a water supply and perfecting the fire department, 188 votes were polled, 102 in favor of and 86 against water-works. Very little interest was taken in the election and the vote was very light. The result of this election authorizes the council to borrow the specified sum by an issue of bonds of the town to that amount, payable in twenty years, and to bear interest at the rate of 6 per cent. per annum.

PHILADELPHIA, PA. An important sewerage ordinance has been introduced in the Common Council by Mr. Hicks, backed by a weighty petition asking for its passage. The bill is to authorize the Mayor to appoint a board of engineers to examine into and report upon the present system of sewers and underground drainage and devise a better system. He is requested to obtain from the American Society of Civil Engineers the names of six engineers who are eminent in their profession, and with particular reference to their knowledge and experience of the best systems of sewer and underground drainage in use in large cities. Due regard is to be had to healthfulness, economy, durability and capacity, and from the list of six names so selected the Mayor is to select two persons who, together with the Chief Engineer and Surveyor, shall constitute the board. It shall be the duty of this board to examine into the defects of the present system of sewers in the city and make a thorough and exhaustive report, embodying suggestions of the best system that can be devised, together with an estimate of the probable cost.

Bridge.—The Rome, Ga., Commissioners of Roads and Revenue have let the contract for two iron bridges over the Etowah river, at a cost of $3,500. The Morse Bridge Company, of Chicago, are the contractors.

NEWS OF THE WEEK.

Contracting.

Union Depot.—A new union depot is to be erected at Sioux City, Ia., by the several railroads entering that city. Chicago architects are preparing plans and work will be commenced shortly.

Canadian Pacific R. R.—An agent of Mr. Henry Abbott, engineer of the line in British Columbia, has despatched over 1,200 men from Montreal and Quebec to the works in that district.

Bridge and Culvert Masonry.—At Delaware, O., contracts have been awarded as follows:

Simpson & Carr, Bokes Creek Bridge, at	$2 79
James Fielding, Stratford Bridge, at	1.75
E. Page, Culvert in Porter Township, at	2.75
Superstructure per 100 feet at	2.25
Smith & Rose, Culvert in Kingston Township, at	3.75
Coping per foot at	12
Excavating per yard	20

Removal of Wrecks.—The following bids for the removal of wrecks of brig "Clio" and steamer "North Heath" lying in the Cape Fear river, North Carolina, have been received by Captain Bixby: W. E. Chapman, Brooklyn, N. Y., $9,970; R. P. Bowdoin, Wilmington, N. C., $16,000; Rittenhouse Moore, Mobile, Ala., $10,987; American Dredging Co. Philadelphia, Pa. $7,500

Parsons & Pacific R. R.—PARSONS, KAN. June 11.—The International Construction Company has sublet the contract for the grading of the balance of the road as far as Coffeyville, the distance being about twenty-five miles. The first contract extended from Parsons a distance of five miles and is fast nearing completion.

C., B. & Q. R. R.—The contract for the Galesburg & Rio R. R., in Illinois, twelve miles in length, has been awarded to C. E. Smith & Co., Mount Pleasant, Ia. The contract price is $300,000 and the line is to be completed by September. Contracts have also been let for the construction of a second main line between Cameron and Monmouth, Altona and Wataga, and Wyanet and Princeton, in all twenty one miles, and completing the double main between Chicago and Burlington. The work will be done this year.

Brick Paving.—The Decatur, Ill., *Republican* comments on the failure of the paving in front of its office; the bricks are soft, and, under heavy traffic, are already chipping and crumbling. It remarks that care now will avoid annoyance and expense in the future. "They must be burned to such a degree that they will not absorb moisture, and to such a state of flinty hardness that the sharp shoes of horses will make no impression upon them. If such brick are used, *and such only*, there can be but little doubt of their success."

Sewers.—Proposals from twenty-seven bidders were opened recently at Philadelphia for constructing five main sewers and eighteen smaller ones. The lowest bidders for the principal sewers were: B. E. Malone, for that on Twenty-fourth, between Hagert and Huntingdon streets, at $16.23 per linear foot; W. H. H. Ashuff for the continuance of the Mill creek sewer at Forty-seventh and Brown streets, at $35.74 per foot, and $12 for repairs to the bed of the present sewer; W. B. M. Conklin, at $2.03 per foot for Girard avenue, between Frankford and Susquehanna avenues; H. C. Eyre, at $19.40 per foot for the sewer on Ellsworth street, near Sixteenth street.

Bridge.—The Grand Rapids, Mich., Board of Public Works have awarded the contract for building the abutments to the Pearl street bridge over the west side canal to Sebel & Davidson, for $4,200, and for the construction of the bridge to the Wrought Iron Bridge Co. of Canton, O., for $3,798. It will be a deck bridge, with a span of 50 feet and a width of 100 feet. The contracts call for the completion of the masonry by July 15, and the completion of the bridge proper, July 17. The Board are now figuring upon the new iron bridge to span the east side canal at the approach to the Bridge street bridge.

Occupation Tax for Street Improvements.—At Little Rock, Ark., an "occupation tax" is now in force in connection with which an improvement district is being formed by the property holders of the principal business part of the city. This will probably secure paved streets, as the revenue from the tax can be applied only to street paving and sanitary purposes; while the formation of the improvement district removes the great objection to this tax, as the property holders will now pay half the cost of the improvement instead of allowing it all to be borne by the merchants and others.

Covington & Cincinnati Elevated Railroad and Bridge Co.—W. G. Bouscaren has been elected chief consulting engineer, and contracts have been let to Messrs. Mason, Hogan & Co., of Frankfort, Ky., and Messrs. Shanahan & Co. Work will be commenced shortly.

Bridge.—Kelley & Wishon have the contract to furnish stone for the building of the abutments of the railroad bridge across the Little Sandy river at Greenup, Ky. It includes excavations, 945 cubic yards; embankment, 61,555, borrow, 66,879; bridge masonry, 2,730; arch culvert, 54; rip-rap, 230; piling, 6,450 linear feet; timber, 18,020. It will be an all summer's work.

Chicago, Cairo & Great Southern R. R.—Bids for the completion of 365 miles of the main line from Chicago to Cairo, and for the branch lines from Marion to Grand Tower, twenty-five miles, and from Marion to Metropolis City, forty-five miles, will be received at the general office of the company—where specifications may be seen—218, La Salle street, Chicago, until June 25.

Cedar Block Paving.—At Chicago bids were received ranging from $1.11 to $1.32. There were nine bids for Franklin street, the lowest being $1.15 and the highest $1.29. It is, however, to be paved by private contract, the property owners paying $1.30 and the city about $1 12 for the intersections. The only advantage in having a street paved by private contract is that the work may be done a month or two sooner, but it costs about twenty per cent. more.

Market Street Bridge.—The proposals for building an iron bridge and its approaches over the Schuylkill river at Market st., Phila. were opened on Tuesday, by Chief Engineer Smedley, of the Survey Department. There were six bidders. The amount of money to be devoted to the purpose was fixed by Councils at $300,000. The bidders were the Edgemoor Iron Works of Delaware, William Sellers, President, at $294,449, the works to be completed within twelve months after notice by the department; the New Jersey Steel and Iron Works, of Trenton, at $277,638.50; the Jones & Benner Company, of Philadelphia, at $311,000; the Keystone Bridge Company, of Pittsburg, at $308,000; the Phœnix Bridge Company, of Pennsylvania, at $294,-266, and R. A. Malone & Son, of Lancaster, at $271,000. The contracts were awarded to Malone and Jones, who have made complete arrangements with Coffrode and Sailer for the ironwork for the bridge.

Street Paving.—Bids for paving and laying crosswalks on the following streets were opened and awards made June 9th by the Department of Public Works. *Granite block.* No. 1, on Pine, Eighth, Ninth and Nineteenth streets: W. KELLY, pavement, per square yard, $2.50; new bridge, per square foot, 45 cents; total, $13,-063.80. Geo. T. Dows, $2.62; 47 cents; $13,669.48. P. H. Fitzgerald, $2.73; 53 cents; $14 299.02. J. G. Smith, $2.55; 45 cents; $13,317.30. No. 2, on Grand street and Washington place: J. G. Smith, $2.69; 45 cents; $16,732.84. Geo. T. Dows, $2.67; 47 cents; $16 623. P. H. Fitzgerald, $2,73; 50 cents; $17,008.68. W. KELLY, $2.53; 45 cents; $15,-754.28. No. 3, on Avenue B: B. MCGRATH, pavement, $2.27; bridge stone, 37 cents; total, $10,136.51. P. H. Fitzgerald, $2.79; 59 cents; $12,737.67. Geo. T. Dows, $2.47; 45 cents; $11,127.43. J. G. Smith, $2.57; 45 cents; $11,340.33. W. Kelly, $2.41; 45 cents; $10,879.69. No. 4, on Monroe street: P. H. Fitzgerald, $2.73; 55 cents; $7,304.95. Geo. T. Dows, $2.50; 45 cents; $6,649. J. G. Smith, $2.63; 45 cents; $6,993.45. W. KELLY, $2.40; 45 cents; $5,403.50. *Trap block.* No. 5, on William street: P. H. Fitzgerald, $2.50; 60 cents; $2,621. D. McGrath, $1.59½; 59 cents; $1,681.75. C. Guidet, $2.33; 60 cents; $2,425.30; J. KEARNEY, $1.30; 40 cents; $1,368.20. No. 6, on Cannon and Jackson streets: M. Shannon, $1.89; 83 cents; $19,348.84. C. Guidet, $2.31; 83 cents; $22,296.84. W. A. Cumming, $1.90; 60 cents; $18,755.80. P. H. Fitzgerald, $2.25; 60 cents; $21,930.30. THOS. GEARTY, $1.83; 51 cents; $17,902.-48. No. 7, on Sheriff street and Center Market place: W. A. CUMMING, $1.79; 49 cents; $5,376.16. P. H. Fitzgerald, $2.05; $1; $6,412.50. T. Gearty, $1.98; 57 cents; $6,020.52. C. Guidet, $2.31; 59 cents; $7,194.84. No. 8, on Ridge street: W. A. Cumming, $1.91; 61 cents; $9,021.53. P. H. FITZGERALD, $1.87; 80 cents; $8,886.13. C. Guidet, $2.31; 53 cents; $10,956.01. D. McGrath, $1.97; 85 cents; $9,363.23. No. 9, on Suffolk street: T. Gearty, $1.91; 59 cents; $9,234.40. P. H. Fitzgerald, $1.99; 90 cents; $9,836. C. Guidet, $2.28; 83 cents; $10,890.80. W. A. CUMMING, $1.84; 49 cents; $8 936.40. No. 10, on Jones and Leroy streets: P. H. Fitzgerald: $1.81; 89 cents; $7,154.47. W. A. CUMMING, $1.90; 61 cents; $7,069.88. C. Guidet, $2.28; 53 cents; $44 209.54. No. 11, on Cornelia and Downing streets. W. A. Cumming, $1.93; 61 cents; $6,402.22. P. H. Fitzgerald, $1.95; 90 cents; $6,634.80. C. Guidet, $2.28; 53 cents; $7,451.-54. THOS. GEARTY, $1.77; 59 cents; $5,830.73. The parties to whom awards have been made are indicated by small capitals.

Harlem Bridge.—The Commissioners have rejected the whole of the bids received for the proposed new bridge. Mr. McQuade's was the lowest for masonry, it being $1,094,000, but he failed to make a combination with iron men, which the Commissioners required, so that although the work might be done by different contractors they would be found as one individual and be required to complete the bridge within a given time. The chief reason for the rejection was that it would not have been in the interests of the City of New York to award on the bids, the Commissioners thinking that in the face of the eight hour movement being unsuccessful they can get the work done much cheaper than would otherwise be the case.

Sub Contracting.—Prisco and Montani, Italian Contracting Co., will sublet part of their work. P. O. Address, Coffeyville, Kansas.

Street Grading.—The contract for the grading of West Bridge street hill, Grand Rapids, Mich., has been let to Wm. Hembling at the rate of twenty cents per yard.

Sewers.—The Sewer Board of New London, Conn., have organized with W. H. Richards as Engineer. The work of building the intercepting sewers will be pushed this season. Rudolph Hering has been retained as Consulting Engineer.

School House.—The Little Rock, Ark., School Board will build a new school house, 38 feet by 68 feet, two stories high, after plans of B. J. Bartlett, architect. Estimated, cost $6,000.

New Bridge.—The Somerset county, New Jersey, Freeholders have awarded a contract to the Canton Iron Bridge Company to build a bridge over the Raritan river at Raritan at a cost of $7,000.

Railroad Grading.—P. B. Winston & Co., of Mitchell, Dak., have been awarded the contract for grading the extension of the Cedar Rapids, Iowa Falls & Northwestern R. R. from a point in Iowa to Sioux Falls, Dak.

Montgomery & Florida R. R.—B. B. McKenzie, Dunham, Ala., has received the contract to build thirty miles of the Montgomery & Florida Railway Co.'s road, reported last week.

Life Saving Stations.—The contracts for building the new life saving stations at Block Island and Cohasset have been awarded to A. F. Blossom of New Bedford, Mass. They are to be framed there and shipped to their destinations. The bids were $5,000 for each station, and they are to be completed by November 1.

Bridge Sidewalk.—The Commissioners of Lehigh county, Pa., have awarded the Allentown Rolling Mill Company the contract to erect a new iron sidewalk 10 feet wide, along the Hamilton street bridge over the Jordan creek, for $13,936. The other bidders were the Phœnix Bridge Company, the Manley & Cooper Manufacturing Company, W. H. Barber & Co. and the Penn Bridge Company, of Beaver Falls.

Street Paving.—The following bids have been received by Mr. J. A. Seymour, City Engineer, Bradford, Pa.: John Smith, Jr. & Co., $2.15; Claflin Pavement Co., $2.87; F. B. Holley, $2.27; M. McMahon, $2.45; Larkin Bros., $2.19; O'Brien and Davitt, $2.22. The prices are per square yard of completed work. The contract was awarded to John Smith & Co., but as they failed to give the required bonds, the contract was then awarded to Larkin Bros.

Railroads, Bridges and Canals.

Cheyenne & Northern R. R.—J. Brown, of Council Bluffs, Ia., the contractor for the first eighty miles of the road, has commenced work at Cheyenne. The contract requires him to have eighty miles in operation by the 1st of January.

San Antonio and Aransas Pass R. R.—This road has nearly completed the first grading contract for 100 miles, which takes it beyond Beeville. Regular daily trains run to Walton, nine miles from Beeville. It is expected to finish the bridge to Beeville (8 miles) this week, weather permitting. Grading at the Gulf began June 1st. Work on Corpus Christi bridge (9,000 feet,) commences soon.

The Northeastern Nebraska R. R. Co. has been incorporated, with a capital stock of $1,000,000. The main office will be at Wayne, whence the line will run to Niobrara. Surveys have been made. The incorporators, who are nearly all officials of the St. Paul & Omaha R. R. Co., are E. W. Winter, J. M. Witman, E. E. Woodman, John D. Howe and S. L. Perrin.

Pennsylvania Schuylkill Valley R. R.—The landslide at Schuylkill Haven has delayed construction work considerably, but the engineers hope to have the road in operation its entire length in ninety days. The formation of the strata is such that the removal of one shovelful of earth from below brings down three or four from above, and a much wider cut than was expected must be made. A great amount of work remains to be done before the cut is properly made. Track laying is going on from Hamburg north and the workmen will be obliged to suspend operations before long. The tunnel is well advanced toward completion and will probably be finished by the time the cut is ready. By September 1 it is believed the new line can be thrown open to travel from Pottsville and to coal trains from New Boston.

TRADE NOTES.

(Twenty cents per line per insertion.)

SAYLOR'S CEMENT.—We used some of the "Saylor's" American Portland Cement in our work, in the wet foundations, on the New York Approach, and found it of first rate quality, and I shall not hesitate to use it in preference to foreign cement, even for the most difficult wet work, and for dry work I should select it every time.

I write this at the request of the "Saylor's Cement Co.", as they are anxious to have the cement used. I should use it if I had work to do. C. C. MARTIN, Chief Eng. and Supt.

BROOKLYN, May 5, 1886. East River Bridge.

MR. HOWARD FLEMING, the well-known importer of Gibb's English Portland Cement, and other foreign brands, has accepted the agency of the High Falls Rosendale Cement, which was employed in the construction of the New York Produce Exchange, Cotton Exchange and Equitable Insurance buildings, and many others. The following announcement is made by the manufacturer, Mr. D. A. Barnhart:

To all whom it may concern: I have appointed Mr. Howard Fleming, No. 23 Liberty street, New York, my selling agent for High Falls Rosendale Cement, and request all orders be addressed to him, as he will in future solicit your trade and arrange settlements of past business.

Market Report of Engineering Materials.

New York June 17, 1886.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.			
Angles		2.00c	@ 2.10c
" steel		2.35	@ 2.45
Tees		2.40	@ 2.45
Beams and channels, American		3.0	@
Tank plates		2.13	@ 2.20
Shell plates		2.4	@ 2.5
Steel plates, Tank		2.70	@ 2.75
WROUGHT-IRON PIPE. PITTSBURG.			
Butt welded, black	Discount		45
" galvanized	"		35
Lap welded, black	"		60
" galvanized	"		42½
Boiler tubes			52½
RAILS.			
Steel (large lots at mill)		$34.00	@ $35.00
Old rails		18.50	@ 19.00
Old rails, steel		22.00	@ 23.00
R R. spikes		2.20c	@ 2.40c
R R. splice-plates		1.75	@ 2.00
R R. track bolts, square nuts		3.00	
Barb-wire fencing, galvanized		4.38	
" painted			4.00
Corrugated iron			
Nails			
Iron, per keg		2.00	@ 2.10
Steel do.		2.55	@ 2.60

METALS.

COPPER.		
Lake Superior	9.95	@ 10.10
Other Brands	9.50	@ 9.75
LEAD.		
Com. Domestic	4.85	
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	$5.50	@ 5.70

BRICK.

Cargoes (afloat)		
Choice Brands	7.75	
Haverstraw, per M.	7.25	@ 7.50
Fishkill	7.25	
Up-River	6.75	@ 7.00
Jerseys	5.50	@ 6.25
Long Island	7.00	@ 7.25
Pale	4.50	@ 5.00
FRONTS.		
Croton, red	11.00	@ 15.00
" dark	11.00	@ 15.00
" brown	10.00	@ 14.00
Philadelphia pressed	24.00	@ 28.00
Trenton "	24.00	@ 26.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	85.00	@ 130.00
" American	80.00	@ 120.00
Fire brick	25.00	@ 55.00
" American, No. 1	30.00	@ 35.00
" " No. 2	25.00	@ 30.00

CEMENT.

The following price current is made up entirely from quotations furnished as directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MEYERSTEIN:		
Hanover Port.and	$2.60	@ $2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
K. B. & S	2.55	@ 3.00
BROOKS, SHOOBRIDGE & Co.	2.45	@ 2.60
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50	@ 2.75
K. B. & S. "	2.25	@ 2.50
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fieve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	$2.40	@ 2.75
GABRIEL & SCHALL:		
Vorwohler "Lion"	2.65	@ 3.10
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.45
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
MARCIAL & Co.:		
J. B. White & Bros. Coarse Keene's	4.25	@ 4.50
" Superfine	7.25	@ 7.50
" Portland	2.45	@ 2.85
NEW YORK CEMENT Co.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35	@ 2.85
K. B. & S.	2.25	@ 2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT Co.:		
English Portland	2.25	@ 2.40
German "	2.00	@ 2.15
Standard	1.50	@ 1.65
Windsor and Improved Rosendale	1.00	@ 1.10
UNION AKRON CEMENT Co.:		
Akron "Star" brand		

ASPHALT.

ROCK.		
Prices range per ton	$15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.

LIME.

Rockland, common per bbl	1.00	
" finishing	1.20	
State, common	.80	@ .90
" finishing	1.10	
Kingston, ground	.90	@ 1.00
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@ 1.00
" " No. 2 "	0.75	@ 0.85
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " " "		
Brown stone, Portland, Ct. "	1.00	@ 1.35
" Belleville, N. J. "	0.75	@ 1.35
Granite, rough	0.45	@ 1.25
Common building stone per load	2.00	@ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	6.00	@ 7.00
Green "	6.00	@ 7.00
Red "	15.00	
Black Penna. (at New York) "	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box	per M.	18.00	@ 20.00
Choice	"	65.00	@ 70.00
Tally plank, 1¼ in. 10 in. dres'd, each.		.44	@ .50
Tally boards, dressed com.	"	.28	@ .30
SPRUCE, Boards dressed	"	.25	@ .28
Plank, 1¼ in	"	.28	@ .30
" 2 in.	"	.38	@ .40
" 2 in. dressed	"	.43	@ .45
Timber	per M.	13.00	@ 16.00
HEMLOCK, Boards	each.	.18	@ .20
Joist, 2½ × 4 to 4 × 6 in		.16	@ .44
OAK	per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2½ in	"	35.00	@ 40.00
YELLOW PINE, Girders	"	25.00	@ 30.00
Dressed flooring	"	28.00	@ 35.00
SHINGLES, Extra shaved pine, 16in.	"		
" sawed 18 in.	"	5.75	@ 6.00
LATH, Cargo rate	"	2.25	@ 2.30

PAINT.

Lead, white, American dry per lb	.04¾	@ .06½
" " in oil pure	.07	@ .07½
" English, B. B. in oil	.08¾	@ .08¾
" Red, American		.06¾
Litharge "	05¼	@ .06
Venetian red, American "	.01	@ .01¼
Indian red "	.08	@ .10
Vermillion, American lead "	.10¾	@ .11¾
Paris green "	.15	@ .18
Umber, Amer. raw and powdered per lb.	.01¼	@ .01¾
Drop black, Amer.	.07	@ .13
" " Eng	.11	@ .13
Chrome green	.10	@ .25
Oxide zinc, American	.03½	@ .06¾
" French	.05¾	@ .07¾